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THE GRADUATE AND HIS WORK *

BY

R. I. REES

American Telephone & Telegraph Company

We have all been reading the educational news in the daily papers, the commencement addresses, baccalaureate addresses, talks to seniors, etc., which have expressed the generalities of this important subject. There is no need, therefore, for us here, in discussion to repeat the broad phases of the relationship between the graduate and his work. The deep and thorough investigation of the Board, and the splendid work of Mr. Wickenden and Professor Hammond, have given us the details of this relationship. Last year, you may remember, I tried to give you some of the modest results of a quantitative analysis of the progress of the engineering graduate in one industry. This study seemed to indicate the conclusion that certain elements in the student's life on the campus had a beneficial influence on his future career.

The subject of the discussion this afternoon is very significant in that it projects the interests of every member of this Society beyond the closing days of Commencement. As Dean Kimball says, it maintains the vital interest of faculty with industry in the student's future career. Mr. Dooley and I talked over this subject before we came here. We decided that we would divide the subject in giving the views of industry, so that we would not tread on each other's toes. It seemed to us that we should go back into the student's college career, and project, if we could, the campus experience of the student into his future life. Therefore, there seemed to be four items which might be considered:

First, the orientation of the student as to what a career in industry means to him.

* Presented at the 37th Annual Meeting of the Society, Ohio State University, June 19–22, 1929.

Second, some treatment of the employment procedure by which the student secures his position.

Third, his placement in industry and his adjustment to his industrial environment.

Fourth, those factors of success on the job which have a direct bearing upon the training that he has received during the undergraduate engineering work.

In the proper division, I was to take the first two of these items, and Mr. Dooley will follow with the third and fourth.

I should like, in the brief time that is available, to bring before you some very practical features in this difficult problem of orienting and of placing a student in his life's career.

One of the things in the interest of the student, which representatives of industry find most difficult to achieve, is to insure that the student approaching graduation becomes thoroughly informed as to the fields of endeavor in industry, and what the opportunities are which will satisfy his immediate, deepest interests, and perhaps further the fundamental motives of his life.

You are familiar with the procedure of representatives of industry in making contact with students. In the interview they have two major objectives. The first is to help the student determine what his deepest interests are. The second is to give him information on the opportunities available within the specific industry represented.

One thing we find is, that no matter how hard we try to get information to the student before the interview, perhaps ninety per cent of the students who come before the representatives, know nothing about our business.

We have a booklet "Work and Opportunity in the Bell System." We try to get it into the student's hands before he comes to us on the campus. Rarely does the student read it; maybe he does not have the time, or perhaps he is not sufficiently concerned with the importance of the decision which he must make in the immediate future. We have found it difficult, if not impossible in the brief time of the interview, to get to the student sufficient information to enable him to make a discrimination between the opportunities in one branch

of our organization and another. Many methods have been tried. Representatives of industry have come to the campus and have talked about the industry. We know how limited that method is, when we consider the wide range of industries. We send information about industries to the personnel office, or to the Dean's office, but there is a doubt as to whether it reaches the student directly enough to impress him.

In discussing a concrete problem, not long ago, with one of the Deans of Engineering, perhaps one of the most fruitful methods, we concluded, if it is not too time-consuming, would be to have a seminar in the senior year on the major industrial opportunities in the country, calling upon the industries to furnish all the necessary material so that a thorough background may be secured by the student through a bit of serious reading. After a thorough investigation of a specific major industry, he would submit a report to the seminar and have it critically discussed by all the members. This is one possible solution that will bring a student before the representatives of industry, equipped to ask intelligent questions and determine whether his interests will be satisfied in the field presented. There may be other and better ways in which this can be brought about. To us, it would seem that there should be fundamental knowledge on the part of the student of the industry which each industrial interviewer represents. We want every graduate to come to us assured that he is going to find the interests which will keep him satisfied and creatively happy on his job.

Now we come to the subject of the actual procedure of employment. I know every representative of industry in this gathering will subscribe to the high degree of cooperation and assistance that is being given by the faculties of the engineering schools. There is one point in the procedure, intimately concerning the faculty, which I should like to touch upon. We consider, and give weight to, scholarship, extra-curricular activities, student's interests, something of the environment, etc. One contribution that we have found of increasing value is the individual expression of opinion on the part of faculty members as to the traits, personality, and gen-

eral fitness, of prospective graduates for the type of work which is offered by a representative of industry. Four years of observation of students by a member of the faculty is something that has more value in translating the interests of the students and in giving their backgrounds, than any other one thing that we can secure as the result of our visits to the campus. This is one consideration which makes it so important that we should come to the campus rather than have the students come to us at our places of business. I believe these values have been increasing in our consciousness from year to year, until now we feel that it is imperative to have the best evidence which you, and you only, can give us before we pass judgment.

We in industry realize that it is a burden upon you for so many of us to come to your campus in search of men. We are really surprised that it does not irritate you more than it does. But it is just this interest in the graduate and his work, in the personal, individual feeling of responsibility that is growing among faculty members that makes you give us this wonderful cooperation. Nevertheless, the burden is increasing. I should like to make two suggestions which, if they could be made effective, might prove helpful. I am doing this on my own personal responsibility; we in industry should discuss them thoroughly:

Would it not be advantageous for the institutions, for the students, and even for industry, if employment representatives of the industries were invited to visit the institutions during a certain fixed period? I think most of us in the major industries cover the largest part of our work with all the institutions in the country within a period of about two months. With us, recruiting begins about the middle of February, with just a scattering of visits before that date. It extends to the fifteenth of April, a period of two months. Of course, it would not be possible, with varying dates of commencement and varying terms, for all the engineering schools of the country to have the same fixed bracket of time, but would it be possible—and I am making this a question for each engineering school throughout the country to invite employment repre-

sentatives of industry to come during certain definite periods?

This is tied in very closely with the second suggestion that I should like to make in this matter of procedure, and that is the desirability in justice to the student, that he have ample opportunity to consider as many of the opportunities that come to him on the campus as he needs in order to make up his mind.

If you should bracket the visits of representatives within a certain reasonable time, it would also be possible then for faculty advisers to instruct the senior to satisfy himself fully that he has made a sufficient number of contacts with representatives of the industries to enable him to make a wise decision in his choice of an occupation. This would guard him against too early an acceptance of the first offer made.

Of course, the corollary of this is that no industry should demand a fixed or too early a date of acceptance or rejection of an offer, or a strict time limit in which a senior must submit his application.

How are we going to get more valid information to the student about the broad classifications of the industries and what opportunities there are in them?

How can we best set up a procedure that will give the greatest satisfaction to the student, be the least burden to the institution and give good results to industry?

These are the two questions brought before this meeting for discussion. Mr. Dooley will have others. I have offered a few suggestions but have given no definitive answer to either of them. I know, however, with the high degree of cooperation now a reality between faculty and industrial representatives, that steady progress will be made in the solution of the problems presented. It is a challenge we all welcome.

C. R. DOOLEY

Standard Oil Company of New York

I would like to comment informally on the problem of getting information to the students through the interviewer. The company representatives—that is as far as my experience

is concerned—have in mind the student's better interests and they tell him that he ought, by all means, to exhaust every possible opportunity either to talk with or to read about every other industry so that when he comes to us he has made up his mind that if he can secure the job, our job is the thing he would like to have, because he has really done some thinking and some investigating. We always tell him not to decide that day because there may be other representatives who will talk with him. We tell him he has plenty of time to make up his mind.

I would almost, General Rees, go so far as to say that if it were possible, we should get up a little booklet and put all of our stuff in print. It would not be complete of course, but we could tell something in those pages. We could send those out and then follow them up with talks. Then we could say that we would be delighted to talk with any boy provided, First: He has read our booklet; Second: He has written some of his qualities on a sheet of paper.

It takes time to ask the lad how old he is, how tall he is, and how much he weighs, and why he came to this school and what courses he is taking. There is a great deal of information which has a bearing on the subject, and yet I can read it while he is reading my story. If he has read the story and hands me his little qualification record, which is not an evaluation sheet but merely a record of facts, we can begin to talk without any worry about hunting for facts. We have the essential information and we are merely checking up on it. He tells me he is the captain of the football team, and I ask him why he chose football over baseball and try to bore into his personality in that way. He reads our paper and we say in there that we use men in China and require them not to be married. He asks me why a fellow cannot be married, and in that way he bores into me for information.

I merely throw that out as a suggestion as to whether we would be justified in staying. We would not interview any student who had not done those two things. Those who have will get our attention just as long as they wish.

Getting a job, as General Rees has described, through this

interviewing process and through any other processes which may be available and where contacts may be made, brings a number of students to our factory and office doors to go to work. I would like to throw in a connecting link between General Rees's two points of orientation and getting a job, my two points of getting adjusted after he gets the job, and then the matter of success. I will give you a simple formula of success with which many of my friends do not agree.

First: To the student: Look the ground over and select the industry or business in which you think you are most interested.

Second: Look yourself over and see which phase of that business you would like to be in—selling, research work, the factory, foreign representation, or which of the four or five major headings listed there.

Third: Take the best job you can find which comes the nearest to those conditions, in the best company—by which I mean a company which has a good reputation and established success.

Fourth: Do anything under heaven that anybody in that company gives you to do, and do it a little more satisfactorily, a little better than the average.

Fifth: Let the future take care of itself.

That is pretty old-fashioned, but I just throw it out as a suggestion. I heard a group of telephone men the other day talking about a man they had seen at one of the colleges. They spoke of other men too and they said one of them stood out as a commercial man and one stood out as a plant man and so forth, but they all agreed that there was one boy whom everybody wanted; he was good for anything. Why? Because he had about made up his mind he wanted to make good in the telephone industry and from then on he was willing to put himself into the hands of the telephone people and say, "I will leave it to you. I do not know what I am good for. Help me find out." Adaptable, adjustable to a certain degree of fixed purpose, and yet flexible enough to fit into their program. All the men wanted him; I would too.

Just to be a little more specific. We have oil field produc-

tion; we have refining—or as we call it, manufacturing; we have maintenance and repair work. We have chemical and engineering research; we have marketing, both domestic and foreign; and we have accounting. Perhaps we have two dozen other things, but those are the major things we have. Perhaps I should add transportation, although the transportation of oil is not very different from the transportation of anything else.

Manufacturing, production and maintenance might all be tied up into what we will call plant manufacturing, research marketing and accounting. The first thing a young man does on coming to our organization—which is quite true, as I understand it, with most of the other big corporations like Westinghouse, General Electric and the Telephone people—is to go through some sort of an orientation process called a student course.

Here is another major point which I would like to throw out to you, that industry today catches this young man as he comes out of college by the process General Rees has described. We catch him in a net, so to speak, and instead of letting him sink or swim as was the way when most of us started out, we catch him with a program and give him a course of training. That course may be for four weeks, it may run pretty well along into a year, but one of the main things of that whole program is to bring about a certain amount of exposure, to let the student have a look into the many phases of our business and to let different department heads have a chance to come in contact with these young men, so they can pick each other out.

I said to a friend of mine the other day, "I am going down to the dog pound to pick out a dog. Have you any suggestions?" She said, "Yes, you just stand around and let the dog pick you out."

You know, there is a lot of sense to that. I tried it and to a very large extent it worked. So, this thing of final adjustment has a good deal of mutuality in it in picking each other out.

Of course, as some of my other friends would say—and I

agree with them, Davis particularly—one of the jobs of the personnel man is to help in that process. Sometimes it becomes important to try to dissuade the young man from the thing he thinks he wants to go into. However, that is a very controversial point. I do not think it is very essential as to how the matter is settled, but I do think it is our business to try to settle it right. At least we can have a conference about it, including the personnel man, the student in question, and several departmental heads, thus doing the best we can to get ultimately each man into his right place.

The object of a student training course is to give a student perspective, to broaden his acquaintance, to give him exposure to the different people and departments in the company, and to give him some information also. He learns a good deal about the refinery and marketing organizations in any other business, and he gets some of the details. He gets technical information about the business, he gets a good deal of personal information of company information, and of company history. The whole thing is a sort of orientation process.

There is another point which is exceedingly important and which many young men do not understand. I am telling you a good deal of this as though you were students. I hope you will forgive me, but remember that I expect you to relay this, if you agree with it, to the boys when you get them back in your classrooms next fall.

A group of students comes to us, highly recommended, highly educated, highly looked over, and to all intents and purposes perfectly sound. Yet we do not know them very well, we do not know whether they are going to be good. We do not know the cardinal virtues of these boys. I had a boy a couple years ago who could not get it into his head that Saturday was not just a kind of a day off. He would go to Philadelphia and see a football game about every other Saturday and even when you called him in and told him about it, he could not remember that Saturday was a workday.

My second point is that through the training process they have to prove that they are honest and reliable, and industrious and punctual. They ought to be willing to submit that

proof. They cannot go on their past reputation because that is gone. That was in another environment. They are in a new place now and they are on their mettle as far as personal qualities go.

Having gone through this training process, or orientation, or learning something about the many processes of the company, and exposing themselves to the company and letting us know what kind of characters they are, they do finally after three or four or five weeks, or months—very often I think it amounts to months—come to their first real assignment. They have a little choice in the matter but not a great deal. There, again, they ought to be flexible and willing to take what comes because of two factors:

First: The personnel office and the company department heads probably know what is best for the boy, better than he does himself.

Second: The chances are that the job he is going to be given to do is one which has to be done and is not the one that he wants. Somebody is to be sent off to another plant or refinery, and there is a piece of work to be done—"Bill, will you do it?"

They should recognize that as a wonderful opportunity. It does not make any difference what it is, the answer should be, Yes, and he should do it so well that everybody else sits up and takes notice and wonders who that man is. You will find different departments wanting that one person. It is not uncommon to find several departments wanting the same man because he "takes hold."

The first assignment, as I say, gives him very little choice, then he finally settles down into a technical job. How many fellows come out of college and want an executive job, gentlemen? Can you not get over to them that executives are never hired, that they are always made, generated, promoted, or shoved up from either a minor executive job or from some technical job?

These fellows start out and their first job is a technical job which they do alone. It is a simple sort of thing. By and by a man may achieve an administrative or technical job. He starts to work toward something higher, which may not be an

administrative job. It may be a very highly specialized corner in the research laboratory where nobody knows much about him but where he produces so many patented ideas that they are willing to pay him highly and let him stay there. That is one channel out of the routine.

Let us get back for a minute to adaptability. All of this machinery of which I am talking is the process of adjustment. All through it the young man has a chance to go to the personnel office or to his immediate supervisor, and talk over his problems and find out whether he fits there or not, and where he would like to go. Then he can put his name on file for a transfer so that in the course of about a year he will make whatever adjustments are in order and will get going in the right direction for him. We have that sort of thing happening all the time.

But, there are going to be adjustments later on too. We put him in the Engineering Department and he starts out inspecting material. Then he comes in after three or four months and says, "I do not like this inspection job. I want a research job."

We talk with him and agree to that. In the course of a month or two we get him transferred. Then after that he may want to be an operator. We do that and he is happy in the job, but then after that he does not want to travel to Youngstown and to Pittsburgh to inspect steel pipe and so forth. He wants to stay in the refinery and work on the processes that get out so many gallons of gasoline a day. They like him there and he is getting along well. Then three or four years later, or perhaps a year or two later, he sends a telegram to Columbus to some girl and tells her he is coming out there to fix things up, and he brings her back with him and they set up housekeeping.

Then he may be four or five years in the plant. The company decides to enlarge its refinery in Sumatra. One day the superintendent says to Bill, "We would like you to go to Sumatra," and he goes home and tells Mary. She says, "We do not want to go to Sumatra." They may have a baby by this time or there may be a community condition where they

enjoy card parties and all those things. I have seen more fellows held down by their girls and wives than any other one thing.

I said to some of the boys the other day when they were kicking about something, "What do you suppose Hoover would have thought of that? He and Mrs. Hoover had their babies and they reared and educated them all over the world. Their home was anywhere." That point has not gotten into the minds of these boys; they want to settle down.

This is a very serious problem. Many companies are expanding and are becoming world-wide affairs. We used to say that about England, but it is almost the same in America now. Companies are expanding and they are merging and enlarging and having interests all over the world. The youngsters should come out of college willing to go anywhere at any time. They ought to train their families to say "yes" to all of that and to go along with them.

I just want to say a brief word on the fourth point of this program. I believe General Rees called that point success. Far be it from me to tell any of you how to succeed. I think I dare say this, representing not only my own views but those of my associates and friends in a similar line of work. We say many times, informally at various lunch tables, that we are not looking for the technical specialist, we are looking for the man with the trained mind, sound character, solid integrity, knowledge of his fundamentals, one who knows his mathematics and physics and chemistry. He does not have to know much about oil chemistry if he knows just plain fundamental chemistry. If he is going to be a research man he ought to have more training in laboratory analysis methods. That gets into a rather specific technical field.

By and large most of the men we want are not skilled, but are trained men with a perspective, with some degree, or the possibility of development of a degree of judgment. We want adaptability, concentration, ability to get along with people, not high tempered and surly people with corners sticking out all the time.

I may be painting too ideal a picture. I think it is im-

portant to paint that picture for a student who goes through your classes. We care about the grades which the boy makes and we care whether he does a good job, but we care a lot more that he should do the very best work he can.

I talked with a man the other day who has a new kind of school up in Cleveland. He told me down at Chapel Hill that he did not have a Dean of Men, no regulations nor rules nor discipline. He said he had over 2,000 students and they were all there for work. He had five or six last year who seemed to lay down a little bit, and he told them to get their hats and their books and "beat" it. Maybe you cannot yet do that, but I would pretty nearly do it.

There are other qualities for instance, serious intention to do the best one can on his job and to throw some originality and resourcefulness and initiative into it.

We were talking at lunch to-day about the boy who was not the star in his class but everybody wanted him. Why? Because he had the qualities. The star in the class may be the one who knows everything about the subject. Once in awhile you will find such a one. He is not neat in his appearance, he is late, and he cannot be depended upon. You have to "jack" him up on reports. We do not want that sort of fellow.

I was talking to one of our vice-presidents the other day. He is a man much older than I am. I said, "You have had a lot of experience, have you any suggestions on how to pick men? I do not know very much about it." He said, "Yes, I will say one thing and that is that I never pick a star. He is too hard to handle."

Personality, manners, appearance—you would be astonished if you went over this country as General Rees and I do, to find that there are literally hundreds of fellows who never shine their shoes, who have no manners about coming into an office.

It is a crime to teach a man the maximum of mathematics and then not straighten him out on his manners. I think you faculty men are responsible for it. I hold you responsible for it. If you see a fellow who needs a few hot shots on his personal conduct, let him have it. He will thank you for it.

Mr. Davis and I were checking up last night. He said—and I concurred with him—that when we go to universities, occasionally we find somebody who needs a talking to and if we think we will not offend too much, we give it to him. Of course, we have no right to do that.

I told of a boy up at one school this year. I looked over his sheet. The sheet is so arranged that if it is blank it looks bad; the amount of ink marks on it tell a lot about the boy. I said to this lad, "What do you do with your spare time?" He said, "I haven't any."

I laughed at him. He had no athletics, no honors, no money earned, no summer work. I told him of that. I said, "You know, I have been through this mill. Tell me honestly what you do with your spare time." He sobered up and said, "I have loafed for four years."

What I said to him was plenty. We had a nice little talk. We have been having a little correspondence ever since.

There was another fellow at another school, and when I got through he said, "Mr. Dooley, my father has told me the same thing many times."

You men know that you are teaching boys, not subjects.

In closing I wish to say that every school I have been to this year has told me that the demand far exceeds their supply. I am sorry to say that the worst is yet to come; the demand for engineers is increasing. This year out of only thirty men whom we want to send to the Far East the word has come, very insistently, that at least eight should be engineers.

These men are to sell oil in China, India and Japan, and not to do engineering work. We want men with engineering backgrounds so they can talk the language of the factory and the shop, and become lubricating engineering salesmen. Just think of it, eight out of thirty. That has never happened until this year. More and more engineers are wanted for different phases of the work. The bookish research man has his own place, but in general business the engineer is going to be wanted more and more. The demand for the technical man is increasing. He is surely becoming the key man as an administrator, as a man fitting into all branches.

As a parting word let me say: Do not be confused about courses of business administration. They should be founded on engineering, otherwise I for one am very skeptical of them.

H. S. EVANS

University of Colorado

The leopard's spots cannot be changed, and we are quite as sure that many human characteristics are equally fixed, yet in spite of this fact we believe in education. Are we justified in this faith in our institutions of higher learning, and, if so, what should we reasonably expect in the way of results?

When a young man matriculates at the age of eighteen, most of his basic habits are fairly well fixed and those various characteristics which make up his personality are fairly well determined. This does not mean, however, that environment is not extremely important. Every individual is both good and bad, and the influences of the immediate society in which his lot is cast will inevitably find responsive chords in his make up which will strengthen his good qualities if his associations are right, or will release and encourage the baser side of life if his associations are wrong.

At this same age the individual's intellectual qualities are also quite definitely settled. Some—I think we can safely say the great majority with whom we have to deal—are growing mentally, and they will continue to grow if given proper encouragement. Others seem to have reached the limit of their mental attainments, and their case is quite hopeless in spite of all the best efforts of friends or institutions. Between these two extremes, we have every gradation from the brilliant student at the head of his class to the poor freshmen who is eliminated because he cannot make the grade.

For our present discussion, we may leave out of account those who drop by the wayside before graduation; but, in doing this, we have not changed the problem except in degree.

The graduating class is made up of a group of individuals each of whom has carried along with him those characteristics which he has received at birth or which have been acquired

through his special environment all along the way. All may have studied the same subjects in college and may be receiving the same degree, but this does not mean that they are all alike. On the contrary, no two are alike either in their personalities or in the knowledge which they have acquired. It is extremely fortunate that this is so, because this would be a dull world indeed if we were able, through our formal and too definitely prescribed educational methods, to trim and compress each one until all would fit the same mould. How should these embryo engineers be dealt with in the attempt to place them satisfactorily in industry?

The technical schools are not employment agencies, but it is safe to say that all feel a greater or less degree of responsibility and interest in assisting the new graduate to get a good start, and many devote much time and effort in this direction. It is a good cause, and in my opinion the members of the faculty and especially the heads of departments should give this important matter a large amount of their personal attention.

Now, from the side of industry, what is one of the most common demands? We receive letters from many prospective employers in which one sentence will read: "We are interested only in those men who stand in the upper third of their class," or possibly some slight variation in the fraction which they would consider acceptable. This form of letter would be sent to any and every school regardless of what reputation it might have for sound engineering training and high scholastic standards. No criticism of those employers who use this method is intended because it is an outstanding characteristic of all of us to desire and to seek for those things which we conceive to be the best. I wonder, however, if such requests, when made as broad as the example I have quoted, may not be based on a too narrow conception of the problem. Have all who are interested in the product of our schools and colleges given sufficiently careful thought as to the meaning, or what at least should be the meaning, of graduation from one of these schools? Most of us have at various times read the figures of statisticians who have computed the percentage of young men

who do successfully complete such a course of training; but when employers, and educators, too, for that matter, are dealing very largely with trained men, it seems to me there is too much of a tendency to make the comparison within the trained group only and not to consider the whole group of young men of about the same age.

To illustrate: All of our boys start in the elementary schools. Almost all of them are able to make fairly satisfactory progress for a few years, but surprisingly soon the weeding out process begins. A very large number, however, finish the elementary grades. A much smaller number enter the junior or senior high school, whichever is provided for them by their local community. A still smaller number finish the high school. Of those who do finish the twelfth grade, a comparatively small percentage enter college. Of those who matriculate, about 35 or 40 per cent are able to finish the four-year course. A process of selection and elimination has been going on for sixteen years of each school class, and, in general, I believe only the fittest have survived. In order to have completed successfully these sixteen years of school and college work, a young man must be possessed of many desirable qualities which will be valuable in industry. Not all can be in the upper third of their class; but all of them, through finishing their technical college course, have placed themselves in the upper tenth or better of the group with which they started. The man who stands in the lower third of his graduating class may not be possessed of the ability to make the highest grades, but in many cases he does have other qualities which will make him even more valuable for the place in industry which he should be given the opportunity to fill. A good personality may be a greater asset than high grades. Every rule has its exceptions, but if at least nearly all of our graduates are not well fitted to enter industry with a good chance to make a success of their life work, then we should seriously inquire, "What is the matter with our school system?" Are we taking good material and spoiling a large part of the finished product? I do not think so, though I would readily grant that our educational methods can and will be improved.

A few years ago, a certain young man stood at the head of his class at graduation. In order to accomplish this he had deprived himself, as far as possible, of all contacts with his fellow students and had taken no part in university or community affairs. When interviewed by industrial representatives, they did not find him interesting. His outlook on life was warped. His success has been only average or below. Another young man who had made excellent grades was denied election to Tau Beta Pi by his fellow students because of personal characteristics which made him undesirable. This handicap has inevitably arrested his professional progress. It is just as easy to recall those men who have ranked very low in class standing and have later made a distinct success in industry. This was possible because they found the place where their particular type of ability could be used to the best advantage. We should also not forget in this connection that the men we graduate are still young and growing. Some have not really found themselves until they have nearly finished their university course. The result is that their four-year class average may be low, but their later development may be rapid. We do have some men in most of our classes who stand high scholastically, have a fine personality, and seem to possess about all of the most desirable characteristics. These men are greatly to be desired, both by the educational institutions and by industry, and we wish that there were more of them.

Since all of these students whom we are comparing, however, are in a highly selected group, may it not be desirable that we should think of our graduates in terms of good, better, and best, rather than good, fair, and poor—which some might prefer?

I believe that industry should study and classify its needs, and with the help of the educational institutions we should all study the qualities and capabilities of **all** the members of the graduating classes, and thus, through a broader minded selection, **every** man from the lowest scholastically to the highest will be needed and will be better fitted to his work. All progressive employers make every effort to guide and

direct the young technical employee into that branch of the business to which he is best fitted, and I believe this is one of the most valuable developments of modern industrial methods. My plea is that we should push these methods back a little further and apply them to the prospective graduates before they become employees. With the types of men and their capabilities more definitely classified and with the needs of industry more definitely understood, I do not believe it would be found necessary to apologize for the lower third of our classes, but that all of this highly selected group might be found to be desirable.

The schools are earnestly trying to graduate men who have acquired a sound fundamental training in mathematics and science with some specialization in the field of engineering which they have chosen. As an outgrowth of the recent activities of this Society, we are also attempting to put more emphasis on cultural and general educational subjects. It is difficult to compress as much of this program into a four-year course as we could desire. This organization is also promoting an active campaign for better teaching and better teachers in the technical schools. We need the help of industrial leaders in all of these things.

Thus we all plan and work for a better arrangement of courses, better teaching, better employment methods, and better post-graduate training; but are we stopping often enough to inquire into the really worthwhile objectives back of all this endeavor? Are we simply interested in turning out better men in order that they may secure better jobs, earn larger salaries, and help promote industrial progress? We are not likely to admit that we are; rather we insist that we are helping to develop better citizens and are preparing men to lead happy and useful lives: that we are training men to live rather than simply to make a living. If this is our real objective, then the emphasis on these things must not stop at graduation.

If I can read the signs of the times correctly, our country is in much greater danger of decay from the lack of good citizenship and a cultivation of the right philosophies of

life than it is from any lack of industrial progress. Many of us remember with deep appreciation of the glowing word picture painted for us by Dean Cooley a few years ago in which he outlined the salvation of this age, and its dependence on the scientist and the engineer, not in their contribution to industrial development alone, but through their broad sympathies and their interest and influence in world affairs.

Our students work hard, they attend classes all day and study most of the nights. When they enter industry, they must also work hard, but I do not believe that they should be expected to work all day and study all night in the line of their specialty in order to promote their own and their company's more rapid progress.

Quoting from a recent article in *World's Work:* "Young men just entering business honestly intend later on to take time to enjoy their families, travel, and really live. But often they find out too late that they have lost the capacity to enjoy anything but business. Many a young wife has watched the gay and facile boy she married change, like Hawthorne's hero, into the Great Stone Face. Her rapidly congealing husband deals in finance by day and by night reads how to get rich quickly.

"But what are the real things? It is the men who are taking time to keep in touch with their families and to learn the zest of something besides business who are really successful."

It would seem to me that a more conservative rate of advancement in industry, coupled with every legitimate means of cultivating a growing interest and understanding of society and its problems, will pay greater dividends in the long run in terms of those values that are most worthwhile.

LOUIS MITCHELL

Syracuse University

With the knowledge that six speakers have been assigned to the same topic, "The Graduate and his Work," I have endeavored to select a theme that would escape the attention of

those who preceded me. Happily such is the case with the topic "The Engineering Graduate in Non-Engineering Work."

This has been an excellent year for the engineering colleges. The demand for graduates has exceeded the supply. Many of the seniors have had their choice of one, two, three or more positions. For the most part, their selection could be made with the definite type of work and geographical location desired. The initial salaries have been satisfactory. Most of the seniors have taken up work that can be designated as engineering or industrial. But according to past experience, about fifteen out of every hundred will later leave this kind of work, and take up distinctly different forms of occupations. The remaining eighty-five per cent will continue with varying degrees of success to follow pursuits of a technical nature.

As one who has a firm belief in the fundamental soundness of an engineering education as a basis of any life work, except where strictly professional training is required, I raise the question as to whether the engineering colleges have given enough emphasis on the value of engineering courses as a basis of preparation for positions in which a technical education is not strictly necessary.

A recent bulletin published by a well known university, is in the form of a catechism about engineering. The usual information for high school students, interested primarily in engineering, is arranged in seventeen questions and answers. The final question refers the reader to another division of the university that prepares men for "business careers." This bulletin is fairly typical of the other engineering colleges in making its appeal to prospective students almost solely on the ground of taking an engineering course in order to prepare for that vocation.

Among my own acquaintances are many successful engineering graduates who are not engaged in engineering. One of my classmates at Purdue University, who received the degree of Electrical Engineer, is manager of a cafeteria in California. In Syracuse, the City Librarian is a graduate in Civil Engineering from Lehigh University. In a local real estate office

is an engineering graduate from the University of Missouri, a member of Tau Beta Pi. Our Director of Admissions at the University is a civil engineering graduate from the University of Washington. In one of our banks is an officer who received a degree from the Massachusetts Institute of Technology. The Assistant Manager of one of our hotels is a graduate in mechanical engineering. A brilliant young Hebrew, who a few years ago held an important engineering position with a division of the City government has recently become a Rabbi in New York City.

Other engineering graduates I could name are now lawyers, clergymen, teachers, physicians, newspaper men, statesmen, college presidents, authors, farmers, insurance agents, photographers, merchants, etc. A complete study of the occupations of engineering graduates who do not engage in engineering would show a surprising diversity of occupations. The list would include many who were excellent students and others who frankly admit they were not "cut out for engineering."

This study strengthens the belief that graduates in engineering who are not contented, or not making satisfactory progress in their chosen work, should be encouraged to enter some other field. It also establishes the conviction, that if engineering education could be properly presented to high school students, it would attract many promising students, who otherwise do not elect the technical courses because they think to do so commits them irrevocably to an engineering career.

More emphasis on the non-technical activities of the engineering graduate might therefore accomplish two things; first, relieve the profession of those not fitted for the work; and second, bring a larger group of the future leaders to the engineering colleges.

It has been my observation that many engineering graduates who leave that field for other activities seem to feel it is necessary to explain to their technical brethren, why they have forsaken the profession. So many seem apologetic—as if they were in effect guilty of desertion and needed to justify

their actions by an explanation of some sort,—usually this is cited on economic grounds.

Such an attitude is, of course, unwarranted. Perhaps it would be better in the long run if more engineering graduates went into the non-technical occupations, especially if this number could include those of mediocre ability, whose lack of progress in engineering makes them malcontents. Many students select an engineering course with only a vague understanding of the scope of the subject, or the work which an engineer is called upon to do. Doubtless many students having once registered in the technical courses feel impelled to go through to graduation without any real enthusiasm for engineering. For much the same reason, many graduates would leave technical or engineering work if they had the courage to do so. They are reluctant to change because it might be regarded as a sign of weakness—a vacillation on their part. Such an attitude is unfortunate and ill-founded.

It is, of course, a matter of pride that so many of our graduates enter engineering or industrial work and follow it with notable success. It is to be hoped that every engineering senior will give engineering a fair trial. If the work is interesting, surroundings congenial, employment stable and promotions fairly frequent, many will find satisfaction in continuing the careers in which they started. Certainly each individual can analyze himself and appraise his opportunities and prospects during the first five or ten years, so that it is possible to take up a new occupation while still a young man, should he decide to make the change. No beginner in engineering should hesitate to transfer to some other kind of work or business if he feels his interest and happiness will be promoted by making the change.

What I have attempted to say may be summed up as follows: The engineering and industrial field offers attractive opportunities to those who have the qualifications, the aptitude and the ability for the work. The engineering courses offer the peculiar advantage of being basic training for general business as well as for engineering. The expense and time expended for an engineering education is not wasted if

a student does not follow that calling. High school students of ability who are destined to become leaders regardless of the course pursued in college, but who desire a general college course, should be encouraged to select engineering even though they do not intend to follow that profession.

Those in industry or other fields of engineering who are not making the progress they desire should—upon due consideration—transfer their efforts to a field of work for which they would be better fitted, and to which they would be better satisfied.

WM. T. MAGRUDER

The Ohio State University

It is purposed to give you some thoughts on "The Graduate" and on "His Work" extending over fifty years. A subtitle might be, "Then and Now." At the time of the Philadelphia Centennial in 1876, only clergymen, lawyers, doctors, and those who were to be cultured gentlemen went to college. For a man to have gone to college and then to go into an engineering shop was to prove that he was queer, off, unusual, or else smart.

If he went to an institute of technology, he probably studied mathematics, physics, and chemistry, each for two or three years; he devoted three years to Belles Lettres, alias English; three years to French and likewise to German; plenty of time to the Beaux Arts, alias drawing, with French curves, German instruments, British water-colors on Whatman sheet-paper, in order to make a set of drawings which formed a "projet." The first angle of projection was used. Shade lines told whether a circle represented a projection or a hole.

Every machinist hardened and ground his own tools and chisels, as every draftsman ground his own stick-ink in a porcelain saucer, slate ones not having come into use. Bottled ink was unknown. To talk about anything less than a hundredth of an inch was to be academic and highbrow. Thousandths were almost unknown and never split. The making of interchangeable parts was almost impossible. Either foot-

power- or engine-lathes were used; and, if the latter, they might be thread-cutting especially for bolts and nuts which were fitted and mated together. An imported steam-engine indicator from Elliott of London was a rare instrument. Isherwood's tests of high pressure marine engines using steam at twenty-five to forty pounds pressure had been made during, and in the ten years after, the civil war. They were the classics of the profession. The work of Charles E. Emery, Will Kent (then just out of college), and others at the Philadelphia Centennial pushed steam-boiler testing up to a high peak. The Centennial standard of 75 lb. gage pressure and 100 deg. Fahr. feedwater were the best possible at that exposition. George H. Corliss could design, machine, select and buy suitable materials, get men to help him, make sales, deliver the engine, finance the transactions, take his pay in half the savings effected, and so prove himself to be an expert in mind, materials, men, merchandising, and money. When Charles T. Porter added weight to the crosshead and piston of his engine, and drove a rolling mill direct and not through a breaker and gears, he was thought to be "off", as the term "energy" was beginning to replace "vis viva" in the language of analytical mechanics, and inertia was a synonym only for laziness.

There were few students then in the half-dozen so-called "institutes," or engineering colleges, and they were usually in civil engineering. They studied land surveying and what civil engineering was then available. Rankine and Mahan were the texts for civil and military engineering students respectively. The mechanical engineering students likewise studied from English or German texts such as Rankine's "Applied Mechanics" and his "Steam Engines" and Dubois' translations of Weisbach.

Steam tables were proprietary. We used a steam table going to 150 lb. absolute pressure "which had been calculated for the Harris-Corliss engine" and which had been used by John W. Hill at the Cincinnati Industrial Expositions in 1874 and 1875 and which was published in his 68-page "Manual for Engineers and Steam Users" and put out by Mr. William

A. Harris as a "guide to the user and to serve as an index to the merits of the Harris-Corliss Engines."

The civil engineer was the man who harked back to the Romans and used imported cement made from British Portland stone. The mechanical engineer was the man who had the mind of the inventor, the manual skill of the artisan, the artistic skill of the architect and sculptor, the business sense and acumen of the banker, and the shrewdness of the salesman of Yankee notions. There were no electrical engineers, and only telegraphers, because Grove, Daniel, and gravity cells were too expensive to operate anything bigger than a sounder and a relay. College shops either did not exist or else were seldom used. The engine lathes and machine tools at one famous eastern technical school were covered with tarpaulins when I visited it in the autumn of 1881. But even so, tarpaulins and lathes were much better than neither lathes nor tarpaulins; and the old basement shop has been twice replaced and now has most-modern and well-equipped factory-like rooms where the students do work of a commercial character instead of the most academic of "student exercises."

Then, most students were fresh from high school and quite academic. Very few students had had any practical or serious technical or business experience. The college-trained psuedo-engineer had to prove both his metal and his mettle, as he was a rara avis. A few employers were willing to try him out, just as some people like to eat an occasional meal at a hotel in order to try out a new food. He was looked on with suspicion as he still is in some narrow, trade-bound circles. Because he was badly handicapped psychologically, he not infrequently met the wishes of his opponents by making mistakes and proving to their satisfaction that he "knew nothing nohow." Because he had not served a five-year apprenticeship, it was considered to be necessarily true that he knew little or nothing about engineering. These prejudices still persist in some circles. They are even still used as hurdles of discouragement, as for example, when one of the national engineering societies in its "Manual for the Operation of a Student Branch" wastes space in repeating the hoary statement

that "it is a familiar expression among employers of engineers that 'it takes five years' experience after graduation from an engineering course before a young engineer is qualified to accept responsibility in engineering work.'" Such "employers of engineers" think of them as hirelings and laborers and do not use them on engineering work as they do not always have enough real engineering work to keep the young men going and so they use them on various forms of clerical and trade work. It is really surprising the large number of companies who apparently do not know how to use college-trained engineering graduates. By flattery, cajolery, and high-powered salesmanship, they induce the young graduate to enter their employ and when he arrives they set him to work on odd jobs of very simple and routine nature. In some cases, he is expected to invent a job and then fill it. The metamorphosis from the encouragement of the classroom to the discouragement of so-called engineering work is almost criminal in that it is likely to kill his spirit. The graduate of today does not so much mind working at a low salary or wages as he does to do routine work continuously which, so far as he can see, leads nowhere, increases his knowledge not a particle, and makes him despise himself for doing the work of an artisan at less than the usual rate of pay for that kind of skilled labor.

Most of the larger colleges of engineering now require the undergraduate to get out into industry and either spend at least one or two summers of from ten to twelve weeks in engineering practice in a surveying corps, an engineering shop or office, in engineering construction work, or similar occupation, before beginning the work of the senior year, or else to alternate five weeks in college and five weeks out of college in a cooperative course. Few of the colleges are now graduating kid-glove engineering students and such as have yet to learn that pull, without push and pep, does not get him very far, that the president of the company is not the employment manager, that one does not use his fist in punching a time clock, and that many a greasy mechanic can teach him and give him much valuable information.

The training to-day is much more practical, experimental, and just as analytical as it was fifty years ago. Then it was academic and solely fundamental, and somewhat British. Twenty-five years ago it was theoretical and somewhat German. To-day it is intensely practical, economic and quite American. We Americans put a bonus on results obtained, even if analysis and looks may have to be sacrificed for economic results.

To-day, there are all sorts, kinds, and qualities of engineering instruction being given by many kinds and grades of engineering colleges. The varieties available in engineering education are just as numerous as are the styles and qualities of goods to be found in a department store. One of our alumni recently listed among the twelve subjects that he was teaching such extremes as descriptive geometry, heating and ventilating, materials handling, valve gears, and aerodynamics. The request has recently been received from an assistant professor of an eastern engineering college for the services of an assistant on an extremely technical and special branch of engineering to teach twenty-two hours per week in classroom and laboratory work for which a salary of $1000 for nine months' work is provided, or about $28 a week, or about $1.30 an hour. I pity the students of a man who is willing and content to work for $1000 a year to impart specialized technical instruction.

To-day, as ever, all sorts, kinds, and qualities of engineering students are being graduated. They vary from the brilliant student possessed of initiative and inventive genius and who frequently thinks little of the financial rewards of his labors, to the student who is more than contented if he makes a passing grade in his studies, but has a good time, makes a fraternity, and possibly dabbles in outside activities. They vary mentally from the analyst, the experimentalist, the researcher, the designer, the productionist, the high-type engineering salesman who can prescribe well for the man whom he would like to serve with his company's output, and down to the mechanic, draftsman, and the order-taker. While few of them know anything about selling their services, they resent the

patronizing attitude of the high-powered personnel salesman, or employer, who tries to stampede the unsophisticated student into an instant decision to go with his company after graduation and intimates that he is conferring a favor on the student in considering him.

In measuring graduates, various yard sticks and specifications are used, depending largely on the work to be done and the point of view of the employer. Height, weight, and athletic ability are called for as they sometimes denote health, ruggedness, and endurance, especially in railroad, steel, and rolling-mill work. Having come from the farm may be an asset for some work; while being city-trained is equally important for other lines. Being a member of a social fraternity denotes popularity, the removal of sharp edges and corners, and the ability to mix and to get along with others. Lack of funds to pay these extra-tuition-fees has handicapped some excellent students who may be working their way through college. Membership in certain honor-fraternities should signify knowledge and brightness as a student of that subject, but may mean only his ability as a lesson-getter and so to succeed. Membership in certain general honor-fraternities means not only high average scholarship for three or four years, but popularity, likeableness, and unimpeachable integrity as he is known to his classmates. Point ratios and grades are indicative of mental ability, attention to the duties and business of the day, and of general intelligence. Taking part in extra-curriculum activities, societies, publication and athletics, indicates breadth of interests, business ability, shrewdness in perceiving the best way to get one's name before the student body with the hope that it may lead to something remunerative while doing what one likes to do. Earning one's income as one spends it betokens thrift, self-denial, self-command, saving the pennies, cutting the corners, but it may also later lead to penuriousness and even to meanness and niggardliness. The necessity to earn one's income and to be self-supporting is the reason why more students do not go out for athletics, activities, and honors—they cannot afford the time and expense.

It should be remembered that at many institutions all engineering college students today partly support themselves while going through college, and that 25 per cent are entirely self-supporting; also that about 20 per cent of each class are married and have to scratch that much harder and have little time for pleasures and past-times which are not remunerative. Again, it must be remembered that engineering college students—at least at this institution—are 0.4 year older than the students of the College of Liberal Arts at entrance and over a year or two older on graduation, due to the fact that only 65 per cent of a class get through in four years, the others being required financially or scholastically to get out and acquire the means to carry on for another quarter or year. This training in dogged determination, steadfastness of purpose, and endurance of hardships forms valuable foundation stones in a subsequent career.

It is very difficult to predict how a group of students is likely to develop in the future, and particularly if they get into unfavorable and discouraging surroundings rather than those that are helpful and stimulating. For this reason personnel managers, employment agents, and men in similar positions have most difficult tasks to perform when they visit a college, meet students singly or in groups, try to draw them out and get them talking about themselves, their past, and their hopes for the future, and then decide at the end of a ten to thirty minute interview whether or not to offer them employment and just where the graduating student will fit into their particular industry and how they can use him advantageously to both parties. Mass-employment of college students does not bring the best results. It is quite surprising that there are not more misfits made every year. It is true that the industries need men, and particularly men capable of becoming executives; but the shut-mouthed student of analytical bent seldom becomes a good salesman even of his own services, nor does the loud-mouthed loquacious individual ever become a development engineer of great originality. Both instructors and employers are likely to deceive themselves and be greatly in error in their opinions and estimates of some students. Personnel

psychology is a study which cannot be mastered overnight. While it may be thought to be the duty of the representatives of the colleges to state certain facts concerning his students when definitely requested, it is also thought to be his duty to warn some would-be employers not to fool themselves. For example, all the cream of the class does not usually gravitate to the company offering the lowest financial and total remuneration. Residence in a beautiful village does not pay the bill contracted with the boarding-house keeper and the clothier. Having earned $150 a month last summer doing interesting work is no reason for giving the employer a 30 per cent discount after graduation. Having earned 75 cents to 90 cents an hour as a machinist or tool-maker, if not more, is no reason why he should spend two years working as a shophand before being allowed to progress. Because some of the graduates of other institutions have no knowledge of the value of their services and are willing to contribute to the profits of the company is not a reason why all other graduates should do likewise. The partial bonus paid for the privilege for working for certain companies in certain localities is rapidly becoming a past practice.

Much has been said in recent years on "Waste in Industry" and referring to the waste of materials and in methods of labor. Unfortunately, little has been said on the more vital subject of waste of men and of using men unwisely. It is too large a subject for this paper, but the day is approaching when the employment managers will have to be psychological and human engineers as is the case to-day with a few companies.

Having kept fairly accurate statistics of the requests made for our mechanical engineering graduates for over a dozen years, I can show evidence that about a hundred employers each year now write in and try to secure men for the over two hundred positions which they would like to fill with our graduates, provided they were available and were of the desired kinds and quality. In recent years some thirty-five or forty companies, and not always the same companies every year, have sent from forty to fifty men, exclusive of scouts, to visit us for from one to six days to solicit the services of the

graduates in engineering, and sometimes those in commerce and in arts, of this university. In 1928, thirteen students accepted employment with the 105 companies who applied. The other fourteen members of the graduating class obtained their positions by their own efforts. Some companies have been sending interviewers and solicitors to the colleges for twenty to twenty-five years. If the output of the engineering colleges really is so worthless, unusable, and so "unqualified to accept responsibility in engineering work" as is alleged, why do companies spend from $50 to $1000 and more to secure this human material from each one of a number of engineering colleges—and keep on doing so year after year—and why do they load responsibilities on the young men, after only a year or two of training? It is not the large and electrical industries alone that are following this practice, but rather those industries and executives whose business is growing, who need the services of those young men who have survived the winnowing process of a four-year college training in engineering, and, most important of all, know how to select them and to use them and their services. The fact is the engineering colleges have become the apprentice school for executives for an increasing number of industries.

The graduates are just as heterogenious as are the undergraduates and their salary is usually proportionate to their personal initiative and value to their company. The salaries of this year's graduates in mechanical engineering at this institution range from $125 under instruction to $275, and average about $150 a month. The alumnus who after twelve years was a draftsman at $130 a month was probably not worth much more. The lazy man who did not have enough initiative to find out who were his company's competitors so that he might offer them his services, probably did not deserve an advancement in rank or salary. Initiative and personality are hard subjects to teach and the successful teachers are rare.

On the other hand quite a few companies have elaborate and successful systems for selecting men and with minute care, using the combined judgment of several interviewers, guiding them forward, training them wisely and advancing them as

they deserve. They find that the hide-bound prejudices of some of the older foremen, superintendents, and executives of the older companies are sometimes almost insurmountable and require much tact and patience and sometimes an executive order for their dislodgement so as to permit the young man to prove his ability, initiative, and worth to the company. It is because of their youth and absence of precedent and tradition that so many of the electrical and automobile manufacturing corporations are able to use college-trained men. It is because of prejudice, custom, tradition and trade-unionism coupled with low-wages to the non-union man, that the railroads do not use more of this type of labor.

The picture that some personnel interviewers can paint of the student, provided he has cooperated in making himself known to his would-be employer, shows remarkable accuracy of judgment and skill in measuring the characteristics of young men. It is compounded of physical qualities and peculiarities, mental and scholastic ability, general intelligence, personality, leadership, initiative, resourcefulness and self-reliance, reliability, industry, accuracy, quickness, thoroughness, neatness, the probability of future growth and development, and above all else of moral character.

To-day, much consideration is given to the study of human aptitudes. The new employee is made to feel at home by the man who employed him. He is assisted in finding a suitable and comfortable boarding house, becoming known and in making friends, and so to develop regard for his fellow employees and loyalty to the company.

The work that the graduate is found to be doing ten years after graduation varies greatly with his branch of the profession. From the figures presented by Dr. Charles F. Kettering, President of the General Motors Research Corporation, and a graduate in electrical engineering of this university, before the Cleveland section of the Society of Automotive Engineers, it would seem that the graduates in electrical engineering are less likely to be practicing that specialty ten years after graduation than are the graduates of the other curricula. From this it may be argued that the curriculum in electrical

engineering gives a broad training which fits its graduates for a greater variety of work. Vice versa, it may be argued that the demand for electrical engineers as trained by the colleges is less than the supply. The roll of the alumni of the department of mechanical engineering of The Ohio State University shows that at least 85 per cent, if not more, of the graduates are practicing some form or branch of their chosen subject. Because a man is not spending his time in a surveying corps, in the shop, or over the drawing board, it does not prove that he has given up the practice of his profession, anymore than it can be rightly said that those soldiers who no longer carry a gun, ride a caisson, or keep the communicating lines in operation, have given up the profession of arms.

The industries are always looking for capable material in the form of men whom they can train for positions of responsibility and to become executives. Numerous companies search the colleges, interview students and professors with the greatest of care and with the hope of finding the unusual man whom they can train. It behooves the engineering educators to cooperate with them in every way possible, fair, and wise. The unusual man needs little assistance. The men who need the care, attention, and guidance of the faculty are those who are not even "average" students because of physical and mental handicaps which they have inherited, could not prevent, and against which they may be fighting. While the world may not owe them a living, industry does need them and can use them. The problem is where and how they can be best employed as human beings so that they can make of themselves the best and happiest of citizens. The demand for engineering graduates who are capable and willing to work is far in excess of the supply and is a vast improvement over the situation fifty years and more ago. The greatest problem to-day before the engineering educator and employer is to fit the graduate to his work and the work to the graduate.

Discussion

President Kimball: Some ten years ago in a certain presidential address which I made in another society, I made some remarks on the future of engineering, and the relation of other technical and trained professional men, such as the lawyer and the place he would occupy, and I was foolish enough to make some predictions as to what the engineer might do. I even prophesied that we might some day have an engineer in the chair in the White House. I had two or three very uncomfortable years on the campus when I met some of my friends from the Law School and other places,—but when I meet them now I stick out my chest.

William H. Timbie: So far so good—but it seems to me that the real crux of this problem has not been touched upon. The representatives of industry have been emphasizing the necessity of picking the right man for the right place and the methods of judging the characteristics of men so that this can be better accomplished. Everything done and said relates to the appraisal of the graduating class. Even the scheme at Cornell is merely such an appraisal. At best it aims to list the characteristics of students in the graduating class so that they may be better fitted into industry. All this does not touch the root of the problem, which, as I see it, is somehow to inform the sophomores and freshmen as to what characteristics and training are desired by the industry so that they may choose wisely their work at the college so as to be sure to fit themselves. Of course we need the appraisal scheme of the characteristics of our graduates but much more we need educational methods which will inform the students of what is going to be expected of them upon graduation. They need to know what the jobs of the first year with a certain industry are like, what they lead to, and the possible paths to places of responsibility, and they need to know it early in their scholastic career, in order to choose the industry for which they have a liking. They get most of this information now from the "scouts" who interview them at the end of their senior year.

Furthermore I do not agree with Mr. Dooley that it is the job of the colleges to organize and to present this information to the students. I think it rather is a cooperative job to be tackled by engineers, industrial leaders and the colleges in common. The engineering profession ought to be making some efforts in the same direction in which the medical profession has been so successful. The young engineer should much earlier in his career attain a professional consciousness and earnestness of purpose similar to that of the young medical student. I believe that the methods used by the medical profession to bring this about could well be adapted by the engineering profession. As soon as a young man enters the medical school he is called Doctor by everybody. When he is home on a vacation physicians of his home town make it a point to invite him to attend any unusual operations. The old family Doctor will often take him around and show him what a general practitioner's day is like. In fact he is made to feel he is one of the profession and he learns by observation and association with physicians just what characteristics are needed in the profession. No amount of formal lectures could give him this information. Similarly I believe that it is practically impossible to formulate this information for the student of engineering and to present it in the class room. In other words, it does not seem to me to be so much the teacher's job as the job of the practicing engineers and the leaders of industry to devise ways and means of getting this information to the student while he is still an undergraduate and can profit most by it. The job of appraising the students when they are ready to graduate and putting the proper tab on each one is easy compared with the real educational task which confronts us.

Carl S. Coler: The opinion has been expressed this afternoon, several times, that the need for engineering graduates is increasing. Statistics show, I believe, that the number of engineers being graduated each year in this country has remained about the same. Engineering teachers and those in the engineering profession are interested in maintaining the proper relationship between supply and demand.

Looking a long way ahead, it would seem that in spite of the present increasing demand for engineering graduates, the need for men in designing, manufacturing and other productive activities will be greatly determined by our ability to distribute the products of industry.

There is a growing need for commercial engineers and I believe that the engineering schools ought to look upon this need as an opportunity to expand the teaching of engineering rather than by turning over the work to other schools which do not give their graduates a preparation in the fundamentals of engineering.

In some of the engineering schools there seems to be an attitude against the man who is commercially minded as compared with those who are technically minded.

I would like to put forth a plea here today for a consideration of this problem. If we see it aright, it represents a challenge to the engineering schools to see that the men who are being prepared for industrial commercial work are given sufficient training in the fundamentals of engineering to insure an ever increasing need for the type of men who can create products.

Cyril M. Jansky: Some things were said this afternoon that are worthy of more extended comment. I refer especially to two statements made by Director Lincoln.

I know that the engineering teachers here will agree with me when I say that our most serious problem is to get students to take pride in scholastic achievement. Yet, Director Lincoln says the industries do not pay attention to scholastic achievement. How are we, as teachers, going to get enthusiasm on the part of students for scholastic achievement if the industries do not want scholars?

The other thing I consider worthy of comment is the statement that in judging the qualifications of graduates of technical schools for employment, scholastic attainments are given a rating of only twenty-five per cent. It seems to me that such an evaluation of the qualifications of young engineers is based on wrong premises. The following experience will illustrate what I consider the fallacy involved in comparing

scholastic attainments with personal character. A well-known director of a school of education prepared a blank for what he called the scientific evaluation of the qualifications of a teacher. This blank had three main headings. The first was entitled Native Efficiency; the second Acquired Efficiency; and the third Projected Efficiency. The qualifications of the teacher were to be rated on a scale of one hundred per cent., which was to be divided between these three kinds of efficiency. No two teachers in the group agreed as to the proper division of the one hundred per cent. The fault lay with the classification and not with the teachers. The first two types of efficiency, when explained, referred to personal characteristics and scholastic attainments respectively, while the last of Projected Efficiency referred solely to what an engineer would call efficiency. In other words, the first two were the means, while the last was the end and it was entirely illogical to attempt to divide one hundred per cent. among the three kinds of efficiency. I wonder if Director Lincoln's classification does not involve the same fallacy. Do not the "Scouts" assume that the candidate being examined has certain scholastic attainments and pay no further attention to the matter, and, furthermore, is it logical to put scholastic attainment and personal characteristics in the same classification? They are not sub-divisions of the same category and, therefore, can not be graded on the same scale. If personal characteristics are worth seventy-five per cent. and scholastic attainments only twenty-five per cent., then why not go to theological seminaries for young engineers?

P. M. Lincoln: I might say, in answer to Mr. Jansky, that most of the "scouts" who come to Cornell simply assume that anybody that has a Cornell degree is good enough for them. What they are looking for are the other qualities, other than scholastic records.

Professor Jansky: Therefore, the twenty-five per cent. has no meaning as it refers to incomparables.

C. C. Williams: Is it not true that in a good many industries the performance during the college career is an index rather than a matter of great intrinsic value in itself? A

good many industries, I believe, do not use calculus in their sales methods nor advance mechanics. They use only plain, ordinary arithmetic and some quasi-English.

If the student has performed well during his residence in college, that fact is taken as an index that he has qualities that will make him successful in their employ. That is to say, he is industrious and he is attentive to business and faithful and so on. Those are the qualities which they are seeking rather than the specific training, perhaps, in a good many cases that he has received in college and his performance in college, which is really only an index of whether he has the fundamentals of character for which they are looking.

George B. Thomas: We do believe definitely in scholastic attainment. The article by Mr. Gifford in *Harper's Magazine* for May, 1928, indicates that in the Bell System there is some correlation between scholastic attainment at college and success afterwards.

In selecting people, when I go to Cornell and talk to Director Lincoln I am quite definite in the statement that the first thing we want is men of scholastic achievement and brain power. There are other things that are essential. A person with brain power but without the ability to use it is not much good. The person with brain power and without reliability is not much good. The person without capacity to cooperate is not capable of carrying on in an organization requiring cooperation.

Those things are essential. However, fundamental and most basic is the ability to think straight. That is what ought to be required for graduation in engineering.

We made a check last week of some 400 of our people taking night courses in New York City, 200 of whom are taking courses leading to a degree. This year ten of them were granted their degrees in engineering by various educational institutions in that City.

The check which Colonel Rees and Mr. Long, Educational Director of the Laboratories, made indicates that those who made the best scholastic standing in their college courses were

on the whole those who were making the best progress in the company.

Harry P. Hammond: I want to ask a question: What is the record, in your laboratory, of the student who got a summa cum laude from our institution—Brooklyn Polytechnic Institute?

Mr. Thomas: I would like to tell that story. It is an interesting human story running quite some time back. I hired that fellow some eight or nine years ago. His name is Francis Farkas a youngster who finished high school and came to work in the telephone laboratories.

After he was on the job about a year and a half he landed in my office one day and said, "Mr. Thomas, I am disappointed. The salary raises have just come out and I did not get what I wanted. I do not think it is right."

Tears came to his eyes. I had had some other people come in the same way a few hours before and they had complained quite bitterly. But, he continued, "I did not come down to complain, I came down to tell you that I expect to go back upstairs on my job and do it in such a way that they will never dare do that to me again."

The boy is still with us. He finished our training course for high school graduates and he made one of the highest records ever made in that course. He followed that up by going to Brooklyn Polytechnic Institute at night. I found out the following fact by reading it in the paper. Also, I found some of it by getting a letter from Professor Beach, and I heard about it from a number of other sources. He stood at the top of the class which was graduated this year and received his degree "summa cum laude." He is the first one who has ever gotten it. It was announced at the seventy-fourth commencement exercises that his is the highest record in engineering ever achieved in Brooklyn Polytechnic Institute either in the day or in the night courses.

I will tell you another yarn about that boy. This happened just yesterday. I called him into the office to congratulate him. When I congratulated him he said, "I did not know I was doing such a good job until they told me

about it and I saw it in the paper. The editor of the *Record* (that is our house organ) called me on the 'phone and asked me to go up and have my picture taken with the other fellows who received their degrees in the night courses. I do not want to do that. I want to remain back and do my job. I feel conspicuous having my picture taken."

That youngster is continually driving at the point of achievement. He is self-effacing. I do not know whether he is going to be one of the best men we have, but I have confidence in him and I rely on him in anything he says. I think he will pull through.

SELECTED PAPERS OF THE SUMMER SCHOOL FOR ENGINEERING TEACHERS

The four papers which follow were selected from among those presented before the Mechanical Engineering Session of the Summer School for Engineering Teachers, held at Purdue University during June and July, 1929, and constitute one installment of a series. They are selected from the "General Division" of the program, devoted to topics relating to all portions of the mechanical engineering curriculum and attended by all members of the summer school group. Other portions of the summer school papers have been published or will be published in the *Journal of Engineering Education* as follows:

September, 1929: Papers relating to the history of mechanical engineering,
October, 1929: Reports of committees of the 1929 session,
November, 1929: Papers of the General Division of the program (the present installment),
December, 1929: Papers relating to educational principles and methods,
January, 1929: Papers of the Heat Power Division of the program,
February, 1930: Papers of the Machine Design Division of the program,
March, 1930: Papers of the Production Division of the program.

These selections from the summer school material will also be published as separately bound bulletins or reprints, the above being Numbers 6 to 12, inclusive, of the summer school series.

Other papers presented before the 1929 Session of the Summer School are appearing in publications of the American Society of Mechanical Engineers. These will be reprinted, collected and bound as an additional number (Bulletin Number 13) of the series, and will be available in that form.

AIMS AND PURPOSES OF MECHANICAL ENGINEERING EDUCATION *

BY DEXTER S. KIMBALL

Dean of the College of Engineering, Cornell University

Mechanical Engineering as it is now constituted started with the industrial revolution of 150 years ago. It had its beginning in men's efforts to build steam engines and the machinery to be driven by them. It has revolutionized industry and men's mode of life.

The first duty of the mechanical engineer is to build the master tools of industry. These machine tools, upon which the mechanical age depends, have grown rapidly in size and power since the tiny lathe of Maudsley, and they now form the basis of our enormous productive capacity.

The mechanical engineer's second duty is the building of steam engines, steam turbines and the other kinds of heat power machines to drive the machinery of industry.

A third field of mechanical engineering is the design and construction of power-using machines, in bewildering variety, in the various specialized forms of mechanical engineering such as refrigeration, ventilation, automotive, aeronautic, combustion, and a host of others.

An important and more recently developed phase of mechanical engineering has to do with production and management. This is a logical outgrowth of the increasing application of machines and power to the relief of man's burden, because the mechanical engineer has found it necessary to apply his skill and his method of attack to the problems which have been brought into being by the production of large quantities of commodities by machine methods.

* A condensed version of a lecture delivered by Dean Kimball before the Summer School for Engineering Teachers on June 27, 1929.

What does this great diversity in mechanical engineering mean to the education of mechanical engineers?

Early mechanical engineers were trained as millwrights according to the apprenticeship plan which was brought over from England. Like the young lawyer who read law in his senior's office, the young engineer was indentured to some designer, builder or manufacturer.

This system produced practically trained engineers, but the method was wasteful and included no cultural education. Even to-day, however, we still think in terms of apprenticeship in many of the handcraft trades. The first concerted, public attempt at formal education specially designed to suit the needs of engineers was that of the Morrill Act of 1862, by which state colleges were aided by federal grants to develop men skilled in the mechanic arts and in agriculture. The exact purpose of this act is not clear, but back of it was the idea that men should combine work and study, an idea that still savored of apprenticeship. In spite of the wastefulness of its unorganized absorptive method, apprenticeship had the advantage of giving an intimate contact with industry which to-day may be gained in other ways:

1. By post-college work, such as the schools of adaptation common in the electrical industry;
2. By spending summers in industry, and
3. By cooperative courses.

To-day we are faced with the problem of training mechanical engineers thoroughly grounded in the principles of applied science, familiar with the special phases of the profession, and with a clear idea of the relation between the technical and the practical. But in addition to this, the importance of the engineer in modern civilization makes it necessary to develop the young mechanical engineer so that he will know as much about society as he does about science and materials and so that he will be familiar with the fundamental principles of our economic structure.

When industry was simple, its heads did not need a technical education. To-day two-thirds of our engineering grad-

uates eventually achieve administrative positions in industry, and the keenest criticism we have to face is the statement that engineers know nothing but engineering.

Engineering should be a profession of well-rounded, liberal-minded men, and in our educational scheme we should open the door for self-development. It is clear that we should keep our thread of engineering instruction intact from the high school through to the engineering degree with a generous wedge of liberalizing courses, preferably largely in the last two years. These liberalizing elements should stress economics and history, history of the race as well as history of the profession. English is taken for granted as a continuing subject of instruction.

Engineering has revolutionized the outlook of the human race. We face still further changes which will come largely as the result of the work of engineers. These men must be trained as competent engineers with the liberal views and poised judgment that will permit them to evaluate the social and economic forces that engineering unleashes. Teachers of mechanical engineering must play a vital part in accomplishing this result.

COLLEGE PERSONNEL METHODS

BY A. A. POTTER

Dean of the Schools of Engineering, Purdue University

Objectives of Engineering Education. Upright character, correct living, service to society, agreeable personality, and good citizenship are objectives in the training of the engineer. Engineering is influencing the lives of all civilized nations, and the engineering colleges have a great responsibility to develop engineers who will have a broad outlook and an appreciation of human values. Engineering colleges must adapt their curricula to the changing needs of the profession and should strive to bring about conditions such that their graduates have the character traits to do right, the ability to think straight, health to work hard, personality to make them acceptable to their fellowmen and the breadth of vision to utilize for the common good the new forces which science and engineering are constantly creating.

A college personnel system is intended as one means of achieving these objectives; it has as its purpose the development of superior character and acceptable traits of personality. Indirectly, it should be helpful in guiding students in the choice of a career.

College Personnel Systems. There is a growing interest on the part of the authorities of institutions of higher learning in placement bureaus, occupational counseling, personnel research and personality adjustment devices for undergraduates. Development of acceptable personality is being recognized as a definite responsibility. Connections between institutions and students do not end in the classrooms of the modern university.

All of the personnel problems of a college cannot be handled effectively by one centralized agency. Each teacher must be,

to a considerable extent, a personnel officer and must interest himself in the development of the mentality, character and personality of his students. The teacher who is in close contact with the student has the greatest opportunity to influence the student's personality, but a centralized personnel agency in cooperation with the teaching staff will lead to more effective results. A personnel system becomes, in fact, a necessity in large institutions, though even in large institutions care must be taken not to centralize such activities unduly. The organization of personnel work for institutions of large and of medium size should include:

A representative committee of the institution to coordinate the personnel activities of the several colleges or divisions.

Decentralized personnel departments, to be organized under the direction of the dean of each college with a director in charge.

Special experts to cooperate with the directors of personnel. These include experts in the departments of psychology, sociology, medicine, physical education, speech, etc. who should be available for special consultation.

Committees representing faculty, students and alumni to cooperate with the personnel director. These should be appointed by the dean of the college or division.

A personnel department to prove most effective, must be a *service* agency but not a *control* department or a *disciplinary* agency.

A Personnel System for an Engineering College. In Purdue University the Director of Personnel reports to the Dean of the Schools of Engineering, has faculty, student and alumni advisory committees, and is responsible for the following services:

Personality Development. This is the chief purpose of the "Personnel Service." A good personality is one of the essentials for success in any profession. It is difficult for the student to see himself as others see him. The "Personnel

System" endeavors to give the student a true picture of himself and this is accomplished in the following manner:

(*a*) After an application for admission has been accepted, and before registration, information is secured from each prospective freshman concerning himself, his family, his part in school activities, hobbies, practical experience and occupational preference. He is also asked to make a detailed self-analysis of his personality in order to focus his attention upon this subject.

(b) In the middle of the first semester of the Freshman year the objectives and workings of the "Personnel System" are explained to the freshmen. Each freshman is then requested to give as references the names of about fifteen people who are qualified to rate him upon his personality characteristics. These must include teachers, students and others.

A rating sheet is then sent to each reference with a request to rate the student on: Address and Manner, Attitude, Character, Cooperative Ability, Disposition, Industriousness, Initiative, Judgment, Leadership and Native Ability. In the directions, references are requested to rate students *in comparison with persons of similar age, educational preparation, and environment.*

As the ratings are received, they are compiled, averaged, and recorded on the *student's permanent personnel card.* If the average of the ratings places the student in the lowest quarter of his class he is invited to come in for a conference with the director of personnel, when his deficiencies are discussed and methods of improvement pointed out. His progress is afterward followed.

This procedure with the three groups of references is repeated in the Junior year. In the Sophomore year, only the student's teachers are requested to send in ratings.

The "Personnel System" focuses the student's attention upon the importance of good traits of personality.

Occupational Information. Descriptive literature of a great variety of industries, special publications, special lectures and conferences are used to familiarize the student with the trends in industry as they affect the technically trained engineer. The student is impressed with the fact that only his fitness for a particular career will determine his success.

Records. The "Personnel Service" keeps complete rec-

ords of the student's personality ratings, scholastic record, results of objective tests, health record and similar data. These prove very useful to heads of schools and teachers in guiding their students.

Early in the Senior year the head of each engineering school (civil, electrical, mechanical and chemical) is supplied with complete information about each senior in his school. This includes, besides other information, the quarter in which the student is placed at the end of the third year in accordance with the grades, personality ratings, health record and special tests. A detailed statement of the occupational preference of every senior is also supplied.

The "Personnel Service" keeps a "Who's Who" of hundreds of companies which employ engineering students. By consulting these records, staff members and students can find out the following details concerning prospective employers: Opportunities afforded the young graduate to gain experience; facilities for making full use of the student's training; past experience of graduates with a particular concern; and its stability.

Placement Service. The director of the "Personnel Service" cooperates with the heads and staffs of the engineering schools in securing summer employment for undergraduates and in the placement of the seniors.

The proper placing of the student upon graduation is very important. Very often this first position influences his whole career as well as his attitude toward industry, the college from which he graduated and the engineering profession. The poorly placed graduate usually blames his college preparation and society as a whole for his failure to make good.

While it is practical to centralize to a considerable extent the personality development program, the occupational information service and the preparation of records, great care is taken to leave the main responsibility for the placement of graduates with the heads in charge of curricula. This is absolutely necessary as the engineering heads and teaching staffs must maintain contact with the prospective employers of their students. Every effort is also being made by the di-

rector of personnel to acquaint prospective employers or their representatives with the specialists in the various teaching departments.

The "Personnel Service" is helpful in connection with the selection of seniors for positions. The director also cooperates with the heads and staffs of the engineering schools in making surveys of positions available in a variety of industries. The *Findex System* with 184 classifications is utilized in nominating students for prospective employers.

The "Personnel Service" also assists freshmen, sophomores, and juniors to secure employment during the summer which will enable them to gain practical experience and at the same time will be helpful to them in occupational selections.

Aid to Alumni. The responsibility of the engineering college to its recent graduates should not terminate with Commencement. The first few years after graduation without question constitute the most difficult period for the young engineer. He is not accustomed to the monotony and drudgery which he meets in industry and is impatient or overambitious.

The director of personnel visits every year a number of industries in which recent graduates are employed. He adjusts misunderstandings, encourages the young graduates, secures special information about concerns for use in guiding future classes and brings about closer cooperation between the University and industry. Such visits must be handled very carefully. The problem of adjusting misunderstandings is a very delicate one and should not be carried so far as to shake the confidence of young alumni in the company in which they are employed.

Considerable assistance is also given to graduates in finding new employment through lists in the alumni publication of the institution, personal conferences and correspondence.

Personnel Research. Special studies are being conducted by the "Personnel Service" as projects of the Purdue Engineering Experiment Station. These have resulted in data concerning the relation between scholastic record and personal traits; improvement in rating scales; also special statistical

data concerning origin and environment of engineering students. Special studies indirectly related to personnel research are being carried on by the Bureau of Educational Reference of Purdue University. Steps are also being taken to enlarge the distinctly personnel research activities of Purdue University.

General Observations. Experience of more than fifteen years with the development of personnel systems for small and large engineering colleges lead to the following conclusions:

An effective personnel system is helpful in improving the personality of the college student. Records, self-analysis and interviews result in focusing the student's attention upon his characteristics as they impress others and upon the development of his talents.

Is there a tendency toward paternalism in connection with such a system? This depends entirely upon the attitude of the personnel officers. A personnel system should be mainly a service agency for the teachers who are the real personnel officers. The personnel director, if he has the proper qualifications, can be most helpful as an adviser to students. The personnel director has also an opportunity to bring about conditions so that each teacher takes an active part in the development of the personality of the students in his classes.

Personality records in combination with the student's scholastic grades have been of great value in advising students regarding the choice of an occupation. Thus, if a student has a poor address or lacks cooperative ability he should be advised to improve these qualities if he aspires to executive responsibilities.

Complete personnel records are helpful in connection with the placement of graduates. In the placement of students the director of personnel should act as a bureau of information and as a liaison officer between the faculty and the prospective employer. He can also be helpful in broadening the field of employment for undergraduates and graduates. His office should never be considered, however, as an employment agency. As mentioned before, the heads of engineering

schools and departments must keep in contact with the employers of their students. A centralization of employment problems in one office has not been successful.

Care must also be taken not to do too much for a student in the way of placement. The personnel director in cooperation with the teachers should aid the student in finding himself. The student should also be supplied by the personnel office with accurate information about prospective employers, but should not be encouraged to expect his college to find employment for him. The personnel director, heads of departments and staff members should act as advisers but not as employment agents.

The success of a personnel system depends upon the qualifications of the director and upon the cooperation of the teaching staff. The director of personnel for an engineering college should have the following training and qualifications:

He should be an engineering college graduate.

He should have had substantial practical experience in industry, preferably in positions where he was brought into contact with a great variety of men.

He should be a person of high character and agreeable personality; one who commands both liking and respect.

He should have considerable training in personnel administration, psychology, sociology, statistical analysis and industrial management.

He should have analytical ability.

He should be able to cooperate with the engineering staff on the one hand and with research specialists in psychology, physical education, corrective medical service and other subjects related to personnel on the other.

He should meet people readily and should have a convincing and pleasing manner.

He should have the ability to interest the teachers of his college so that they become personnel officers for the students in their classes.

He should see in large perspective—have a sense of humor.

He should have the ability to secure cooperation of students and staff in personnel problems.

Every engineering college, small as well as large, should give

attention to the proper development of the student's personality. The system here described may be too elaborate for the college of 250 students or less. However, with minor modifications this system and types of records will be found satisfactory for a college of any size. In the small college the dean of engineering may be the personnel director.

The cost of a personnel system depends upon the size of the college. For colleges with an enrollment of 1000 or more the expenditure of about $7.50 per student per year should result in an effective personnel system. This cost per student will increase as the size of the college decreases, but in any case it is very inexpensive if the results are considered.

ORGANIZATION OF COURSES IN MECHANICAL ENGINEERING SUBJECTS FOR NON-MECHANICAL ENGINEERS

BY S. W. DUDLEY

Professor of Mechanical Engineering, Yale University

The Problem. The organization of any course of study, for any group of students, may be approached either with the subject or with the student uppermost in mind. Stated thus bluntly, there is little room for argument about which point of view will lead to the most effective program. But there are many collateral interests, more or less directly affecting the result, which must be given due consideration, first, in the selection of the subject of study, and next in method and treatment.

If we assume, as our primary objective, the development of the student, we must start with the student—his major interests, his needs, realized or unsuspected, and his previous experience. Next come the qualifications of the teaching staff to meet the real needs of the student group. With these major requirements satisfactorily provided for, questions of quality and extent of subject matter, and its adjustment to the time available and other limitations become largely matters of detail.

The significant factor, however, is not so much the form of organization employed in the course as the attitude of the department or the individual in charge. Regardless of the structural features of the plan, its effect upon the student is determined by the personal attitudes, the points of view and the objectives developed in the class, the lecture and the laboratory presentations from day to day.

When laying out course programs for mechanical engineering students the progressive development of the student throughout the entire undergraduate and possibly graduate

years is considered. The courses are correlated with this in view. An attempt is made to proceed from the broadly fundamental disciplines to the specific and technical applications by a series of orderly sequences, as systematically organized as circumstances permit. The courses are thus fitted into a complete plan for a particular group of students and branch of engineering.

Thus, there grows up an unconscious standard of reference. Students from other departments are assumed to differ in some way from this type. It is not uncommon to find the essential differences in curricula, and in certain methods and formal requirements, carried over into an offhand pigeonholing of students from other departments as necessarily a different type of individuals with different standards, or reactions, or natural endowments. Teachers in mechanical engineering courses are prone to consider students from industrial or business administration courses as lacking in thoroughness and seriousness of purpose. Electrical engineering students have been branded as more irresponsible and boyish, and less responsive to orderly methods of attack upon problems. Civil engineering students are sometimes cataloged as static in temperament and thinking.

These distinctions may even extend to misunderstandings and a lack of complete coordination between the departments themselves. It is not surprising that specialists in one field, thoroughly convinced by experience of the merit of methods and aims best suited to their field, should view with genuine misgivings the different methods and objectives which may be found in other fields, simply because they are different. This implies no animus, but only a natural tendency for any one of us to appropriate to our own tried and proven methods a virtue which, by unsuspected implication, often influences our judgment of other cases in which, possibly, the conditions are not at all comparable.

In this I find myself in hearty agreement with the conclusions of the Committee on Heat-Power Courses for Non-Mechanical Engineering Students,* with reference to better

* The report of this committee will be found on page 166 of the October, 1929, number of the JOURNAL OF ENGINEERING EDUCATION.

cooperation with other department staffs and better correlation with related and prerequisite courses. That there is sometimes a reserve between departments, is a matter of common experience. I have been told, with much vigor and positiveness, by teachers of electrical engineering, that mechanical engineering faculties are usually dissatisfied with courses given their students in the Electrical Engineering Department. A better understanding of the whole situation, which can only come through free and informal discussion, as suggested by your committee, will dispel most disagreements.

The same attitude of considerate open-mindedness should also govern in organizing our own courses for "out-of-course" students. Such students will respond with the same varying degrees of interest and intensity as our own students to the attitude and effectiveness of the teacher. The subject, and the student's relation to that subject as an *individual*, not as a civil or electrical or mechanical engineer, are the significant factors.

Policy Regarding Curriculum. The policy of the department with respect to its offerings for "outside" students will vary according to the size of the institution and its facilities, its educational characteristics, and many other existing circumstances, in addition to the preferences of its faculty.

The policy of the institution may be definitely in the direction of fixed and standardized courses or it may be liberal and flexible. It may emphasize fundamental theory and rigorous discipline or tend strongly toward the practical and utilitarian. Courses for non-mechanical engineers would necessarily partake of the nature of their environment in these particulars and consequently no general rules apply.

Within these limitations, however, there is always a question of policy to be decided. Shall such courses be historical only—a sort of story about mechanical engineering or a survey of the development of mechanical engineering? Or shall they bring the "outside" student into direct, personal contact with some branch of mechanical engineering, thus giving him a

sample, perhaps small and somewhat arbitrarily selected, it may be, but a true sample? If "experience is the best teacher" it would seem preferable to give the "out-of-course" student a bit of actual experience with some typical mechanical engineering subject within the range of his preparation and needs, rather than to attempt to show him what mechanical engineering is in its entirety.

Content of Courses. In some cases the courses may well be identical for "home" and for "foreign" students. For example, at Yale the electrical engineers are required to take a course in Thermodynamics and Heat Engines. The mechanical engineering department considers these students better served by the regular recitation and laboratory course in this subject, as given to its own students, than they could be by any specially arranged course. Experience has shown that the electrical engineering groups sometimes do better work in this subject than the mechanical engineers, and sometimes vice versa. There is no indication that either group, because of its distinctive field of interest, has any advantage in aptitude for this subject. Both departments concerned are satisfied that this plan is working well.

The mechanical engineers are required to take an elementary course in electrical engineering, the fundamentals of A.C. and D.C. circuits and machines. Owing to the limitations of schedule requirements, it is not feasible for the mechanical engineering students to take the fundamental courses offered electrical engineering students. In this case a special course is arranged by the department of electrical engineering. The course is made comprehensive and rigorous, with as much by way of professional and practical illustrations as time permits.

These are cases only. They do not prove any general thesis or tendency. They are mentioned as instances to show the need for considering the problem of each course of this character with regard to the circumstances of that particular case. Sometimes there is not a regular course in the department available to meet the requirements of another department. For example, the Industrial Engineering Department at Yale

desires its students to have a course in the fields of civil, electrical and mechanical engineering, which will give them some insight into the material and methods of these fields. In electrical engineering the course above referred to is offered. It appears to meet the needs of these students very well. In mechanical engineering a course also especially designed for this group of students is offered. The attempt to include the elements of several branches of mechanical engineering in this course, in order to sketch the general features of the whole field, results in no very thorough treatment of any portion of the field. Both departments concerned are inclined to the opinion that a more thorough treatment of some typical division, such as Engineering Design or Heat-Power Engineering would provide more lasting and substantial values. In other words, a typical technical discipline course in the field is believed to be worth more to the student, both as an intellectual stimulus and as an experience, than a survey or a general information course attempting to present an encyclopedic summary of the entire field.

When a course especially adapted to the preparatory background or schedule limitations of out-of-course students is required, it would seem preferable to use the same methods of recitation, laboratory and occasional lecture or inspection trip as for the regular course. The differences can best be made in the cultivation of a more limited area but without essentially changing the depth or intensiveness of the cultivation itself. In principle, therefore, the same treatment of all students would appear to ensure the best results because in background, in training, in ultimate aims, and in personal qualities there are not sufficiently marked differences in the groups to justify material variations in content, methods of presentation or standards of performance required.

Organization. The best results will usually be obtained if "home" and "foreign" students can be handled together. In institutions and courses where numbers and preparation permit, the problem usually disappears—there is no difference noticeable. But this combination is not always practicable. Experience with mixed groups indicates that when the groups

are separate the same principles should be followed as far as practicable. That is, the amount and character of instruction should be planned with reference to the time allowed and the relative importance of the available material without attempting to make allowances for supposed differences in the traits of different groups of students. If the same instructors can be used for both groups, so much the better, as this will minimize the tendency to differentiate.

It will be noted that the plan advocated looks toward the development of the powers of the student rather than the offering of a package of assorted and predigested facts, methods and rules. As President Davis, of Stevens, has so aptly phrased it in his inaugural address: "This employer actually prefers the activity that is born of ignorance" (of details, be it noted in passing) "to the knowledge that is imparted by a specialized curriculum."

Progress in the increasingly complex maze of specialized applications which the graduate will encounter on his first job, depends chiefly upon a command of these elements to which access and mastery is difficult when under the pressure of professional or industrial practice.

The particular subjects offered to "out-of-course" students are thus of less importance than the manner in which they are presented and the standards and objectives toward which they are pointed. Whether the subjects be of the fundamental, the technical or even the frankly utilitarian type, they can be so organised as to emphasize the interdependence of theory and experience, of an understanding of general principles and a high degree of skilled technique of breadth of viewpoint and penetration of vision,—in a word, of thought and action.

When time is inadequate (and in such cases time is always inadequate) the pressure is in the direction of the "practical" type of course, usually most alluring to the student and easiest for the instructor, but seldom offering intellectual stimulus or developing intellectual capacity. Some degree of illustration by practical applications and experience with typical apparatus, methods and instruments is needed to lend variety

and definiteness to any course. Carried too far, valuable time and opportunity can be lost.

This does not overlook the great advantages to be gained by a thorough analysis of some typical machine or project. Such analytical studies develop powers of observation and reasoning and disclose principles and relationships whose value is quite independent of the case selected for study, the type of apparatus used or the routine operations involved. But to do a thorough job of this kind usually requires more time than the more common, or what might be termed the "synthetic," method of attack. Certain courses, such as Engineering Design, some phases of Management, Automotive courses and the like, are well adapted to this method and it is being used effectively, especially in classes where segregation of students according to scholastic ability is possible.

There is no formula, however, to relieve us from the necessity for considering each case on its merits. Each institution and each course will present individual features; differences which are often small but may be determinative. The scientific method is just as necessary here as in the selection of a suitable furnace design for a power plant or the choice of a machine tool for a manufacturing process.

At the Sheffield Scientific School the courses in Automotive Engineering happen to present certain typical questions of policy. There is a demand for elective courses in this field from students in other engineering departments, from students in the School not in engineering departments and from students in the Arts College. At present this demand appears to be best served by providing two types of courses, one suited to the previous experience and interests of those men trained in mathematics, pure and applied science, materials, design and so on; the other adapted to the background of the non-engineer having the requisite minimum of mathematics and science.

This does not mean that for the non-engineer a purely descriptive, lecture type of course is indicated. While the organizational problem presented by this group is more complex, it is possible to arrange material and establish standards

which will provide just as substantial disciplinary training for this group as the more intensive and comprehensive technical treatment required for the engineering students.

The standards of relative mental effort and of grading should be the same. The range of subject matter should be different but the relative intensity of treatment, within the capacity of the groups, should make equal demands upon the students' mental powers.

In discussing this problem of organization with the staff of another department, from which a large group of students regularly come for courses in automotive engineering, the following specific policies were agreed upon:

1. Non-mechanical engineering students taking required or elective courses given by the Mechanical Engineering Department, should be subject to the same conditions and regulations which the Mechanical Engineering Department applies to its own students.

2. Non-mechanical engineering students should not be admitted to elective courses for which they have inadequate preparation.

3. In courses organized primarily for mechanical engineering students, students who take the course should be required to perform the regular work and conform to the regular conditions of the course, no exceptions of any sort being made on the ground of lack of prerequisite training or otherwise.

4. Courses given especially for non-mechanical engineering students should require as difficult and as advanced thought and work as similar courses given for students of the Mechanical Engineering Department. If present courses do not provide sufficient material of an advanced nature to measure up to this qualitative standard, they should be revised to include more advanced work, even if this involves contracting the number of subjects studied in order to go more deeply into the principles of the more important subjects.

5. A graphical record should be kept of the marks in each course for non-mechanical engineering students and these records should be considered when discussing the problems involved in raising the standards of courses for such students.

6. The faculty teaching non-mechanical engineering students should meet with the members of the other departments concerned to consider their problems and the progress being made in raising intellectual standards.

The Student and the Teacher. The organization of courses in mechanical engineering subjects for non-mechanical engineers should proceed basically according to the same principles and standards as for the mechanical engineer, namely, a consideration of the student as an individual, his previous scholastic experience, his basic needs and his interests, both fundamental and passing. In these respects students from all departments are more alike than they are different.

Here, as always, the attitude of the teacher becomes, after all, the determinative factor. He stands between the student and the subject. His obligation is to stimulate and guide, to unfold and explain, to inculcate correct viewpoints and habits. His obligation to his subject, as well as to his students, is even heavier when dealing with "foreign" students than with those within his own department. The non-engineering student with the hasty, offhand generalization of youth, is prone to look for and magnify differences in method, or standards in different courses. If the instructor fosters this tendency, consciously or unconsciously, he may seriously distract attention from the essential values of the course. Recognizing the place and function of the other departments and the other subjects in the complete structure of each student's program, he can give full expression to, and stimulating exercise in, the selected phases of his own subject, without suggestion of or possibility of disparagement of any other departments or subjects.

Whether his interest in the subject be that of the scholarly investigator, the expert practitioner, or the educator, he cannot afford to overlook the importance of each of these viewpoints in the selection of his material and the method of its presentation. As a teacher, his primary responsibility is to his students, using his subject as a means for their stimulation and development and not as an end in itself.

THE MECHANICAL ENGINEERING DEPARTMENT: ORGANIZATION, MANAGEMENT, METHODS OF INSTRUCTION, COST OF OPERATION

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Inasmuch as the courses in mechanical engineering as laid down in most of our technical schools include those subjects which are the fundamentals of all branches of engineering, the staff in mechanical engineering is called upon to teach such important subjects as Machine Design, Thermodynamics, Mechanism, Applied Mechanics, Testing of Materials, Engineering and Power Laboratory Work, not only to the students in their own department, but also to those in the other departments of the institution.

At the Massachusetts Institute of Technology fully fifty per cent of the time of the mechanical engineering staff is spent in teaching students registered in other branches of engineering. On this account the staff is larger in proportion to the number of students registered in mechanical engineering than that of some allied engineering departments.

Naturally students in mechanical engineering are given much more complete and detailed instruction in the various subjects previously mentioned than the students of other departments. There is never any difficulty in keeping students interested in a subject which they feel is a professional subject. There is, however, difficulty in keeping up the interest of students in, let us say, engineering administration, in subjects like Machine Design and Thermodynamics, unless the instructor chosen to teach these men has the ability to convince them that the work is to be of use later, and unless he holds their interest by giving them problems which they can easily see are actually applicable to the line of work they

hope to pursue. It follows, consequently, that those members of the staff who are selected to teach mechanical engineering subjects to engineering students other than mechanicals, must be men of experience.

Internal Organization of a Department

In my judgment, the head of a department should put one of his staff in charge of each separate branch of the work, giving the one in charge such professors and instructors as he may need to assist him, it being understood that each of the men assigned to any branch is to prepare himself to step into the shoes of the man who is his immediate superior. The organization should be in many respects like that of an army, the various divisions of the department corresponding to the various branches of the service. The professor in charge of a division of the work, like the colonel in charge of a regiment, should be responsible to the head. The one in charge of a division should be given to understand that he will receive credit for any advances or any improvements which he may make and that his request for funds needed to carry out any betterments will be honored if funds are available. The best way to develop initiative is to give a man authority and then to support him in his decisions. At Technology the organization of the Mechanical Engineering Department is such that the head of the department cannot use the equipment of a laboratory without getting permission from the professor who is in immediate charge of that particular laboratory, or, in his absence, from the next in command. This arrangement has been found to work admirably and without any friction.

The engineering departments of some of our schools in America are operated as what is sometimes called "a one-man department;" where the head of the department decides everything himself. A department operated in this way soon deteriorates, all initiative is killed and the members of the staff lose interest in their work. On the other hand, it may be said that where professors in the different branches are each given free opportunity to develop their branch, inasmuch

as some professors are more progressive than others, it is likely that one professor will develop his particular branch faster than another professor.

A number of years ago when I had occasion to study foreign schools, such a condition was found to prevail in a number of the technical schools in Germany. This fact was brought out in a report on foreign schools which was made to our Corporation. Dr. MacLaurin, then President, in order to prevent such unequal development of the laboratories at Technology, appointed a committee of six, consisting of one member from each branch of our engineering laboratories, namely: Steam and Compressed Air, Strength of Materials, Hydraulics, Gas Engine, Power Measurement, Refrigeration. This committee was instructed to see that any surplus left in the operating budget at the end of the year was expended in developing that laboratory which was not growing as fast as it should.

Laboratory Procedure

It may be of interest to consider methods of instruction in such a laboratory, say, as Steam, Compressed Air and Hydraulic. With small sections it is possible to have the students start the apparatus, decide on what observations are needed, on how frequently observations should be taken, and on what length of test is necessary to give the accuracy desired, the instructor taking no part unless called upon by the student. While this method is rather hard on the apparatus, it is in my judgment well worthwhile, as the students not only get thoroughly familiar with the apparatus, but also acquire a confidence which makes them unafraid to operate any piece of similar equipment, no matter what its size. This method, however, is not feasible in classes as large as we now find in many of our engineering schools. We have found it necessary at Technology on account of the large number of students, to adopt a different scheme which has been in effect in our Steam, Compressed Air, Hydraulics, and Power Measurement Laboratories for the last six or seven years. Our large numbers are due to the fact that these laboratories are used by all senior students in our ten largest courses.

In order to give instruction to these large numbers it is necessary to handle the job in a methodical way. A system has been devised which makes it possible for one attendant in the instrument room to take care of the routine laboratory operation and also to conduct a post office for the return of corrected problems and reports.

The latter service will be described first. Each student due to attend classes in Heat Engineering, which subject is a prerequisite for all laboratory work, is assigned a number at the beginning of his Junior year, which number has been designated a "Return Number." This number is placed conspicuously on all problem sheets submitted in connection with his courses and after the inspection of the problems by the instructor these problems or reports are sent to the instrument room where they are distributed to boxes suitably numbered. The post office consists of 160 pigeon holes numbered for ten units to each box, i.e., to accommodate 1600 students. The post office window is open three hours daily and students call for their corrected problems by number. They are served in a fraction of the time that would be required if an alphabetical system was used.

The laboratory class work is carried on according to a schedule prepared previous to the opening of each term. Every period of each term, a student section reports to the laboratory, according to the assignments of the "Tabular View." The section is divided into groups of five or six students each. These groups work as units throughout the term. After the first exercise the schedule for each section is posted and thereafter any student can know what equipment he is to work on at each laboratory period. The instrument room copy of the schedule is marked to show which instructor is to take care of each class.

The instruments and tools required for the laboratory exercises are kept in separate kits for each piece of laboratory apparatus. These kit boxes are arranged so that each instrument fits into a special place and if any article is missing it is obvious at a glance. The kit boxes are numbered and

are kept in numerical order. The laboratory instructor's assignments are posted in the instrument room on a board arranged as follows: In a vertical column at the left are the instructors names. Across the top of the board are printed the hours of the day. A horizontal line across the border under each instructors name and vertical lines after each hour divides the board into small squares. There is a hook in each one of these squares. The instrument room attendant hangs numbered checks on these hooks, the number in each one of these squares. The instrument room attag signifying both the time of the class and the instructor assigned. Two of these boards are used, one for to-day and one for tomorrow. The attendance cards for the proper groups of students are put into the several kits before the time for each class so that when an instructor carries a kit to class he not only has the completed equipment needed but also has the names of the students for the particular exercise and can check the attendance on the card.

Each student submits a report for every laboratory exercise and drops it into a box at the instrument room. Every report submitted has attached to it a paper slip, about eight inches wide and four inches deep perforated horizontally one inch from the top and vertically through the center. On the left hand side of the vertical perforation is a space for the student's name, his return number, course, the name of the apparatus which the report covers and the name of the instructor. There is also a space for the grade given and for noting whether or not the report has to be corrected. On the right hand side of the slip there is space for the student's return number, for the name of the apparatus, and for the date on which the report was received.

The reports left each day are picked up the following morning and the date received is stamped on the report and on the right hand coupon of the slip. This coupon is then detached and filed in numerical order, the return numbers, previously explained, being used for this purpose. This file of coupons makes it possible to know at any time whether or not a student is putting in the reports required at the time they are due. These coupons on the right hand side

having been removed, the reports are then sorted according to the instructors and taken away for correction.

When the report has been read the grade is marked on the left hand coupon of the slip which is still attached to the report. Each instructor delivers to the instrument room daily the reports he has corrected. The slips are removed and the reports distributed to the post office boxes for return to the students. The slips bearing the grades are sorted in numerical order and then the grades are posted on record cards which are kept in a Kardex file. Approximately 10,000 reports are handled in this way each term.

The record cards are 6″ wide and 5″ deep. The printing on both sides contains the names of eighty odd experiments which may be run as class work. Space opposite the name of each piece of apparatus is kept for recording the preliminary and the final grade or mark given. The student's name and return number are also entered at the top and bottom of each side of the card.

In case a report is to be corrected the original grade is posted as "Preliminary." This is indicated on the grade slip.

The record cards are printed on two sides so that the complete record for all laboratory work is on one card for each student even though the courses may have been taken in several terms. At the end of the term the record cards are rearranged and filed in alphabetical order.

The instrument room clerk also makes a weekly schedule for the operating engineer in the laboratory so that he has the required apparatus in readiness for such class. Thus from the master schedule in the instrument room the student, the instructor, and the operating engineer are severally informed in advance of their laboratory assignments and duties.

Laboratory exercises in the Testing Materials Laboratory and in the Concrete Laboratory are conducted in a manner similar to that followed in the Steam and Hydraulic Laboratory.

The laboratory reports required are of three types, the type depending upon the nature of the experiment:

1. Formal reports giving all the data obtained, the calculation of results, the discussion of accuracy of the work, and including conclusions drawn.
2. The reports to be made on standard regular printed forms without discussion of results.
3. Class-notes. These are taken during the test and during the discussion which follows the test. At the end of the exercise from twenty to thirty minutes are allowed a student to complete his notes before handing them in so as to enable him to add such discussion of the results and such comparisons as he may see fit to make between the results he obtained and the figures commonly quoted in the textbooks used in connection with the laboratory work.

The last exercise of each course is devoted to oral quizzes. In groups of from four to six men the students meet with two or more of the instructing staff (three whenever possible) and are questioned concerning the work of the course. Questions are asked covering the subject matter of the textbook used, laboratory procedure, machines, instruments, specifications, interpretation of graphs and fractures, the interrelation of properties and specific data. During the hour devoted to such a quiz it is generally possible to submit to each student four or five series of questions. Each examiner is given opportunity to propose items for the student to discuss. Each examiner grades each student and the concensus of opinion determines the grade to be recorded. For a period of over two and one-half years this method has superceded that formerly used in which each student was subjected to a two-hour written examination. While the present method increases the load on the instructing staff from fifty to one hundred per cent during the closing weeks it is felt that the results are well worth the extra labor.

The undergraduate instruction which is given in the Gas Engine Laboratory is of two types: one, the regular tests for efficiency, power developed, engine characteristics, etc.; the

other arranged especially for Officers of the U. S. Army includes besides the ordinary tests, about one hundred hours of work spent on *"troubles"* or what to do to put a crippled engine quickly into service; in other words, these officers are trained to be expert diagnosticians on engine troubles.

Laboratories for machine tool work, forge, foundry and pattern work are a necessary part of the teaching equipment of a mechanical engineering department. The tools should be changed as often as may be necessary to keep the equipment up-to-date. No attempt should be made to turn out expert mechanicians. Effort should be made, however, to familiarize the men with the particular use of each tool. This may be done in the shortest time by giving the students special isolated pieces to construct, each piece having been planned to bring in the use of one or two tools. If the schedule of pieces to be made is properly planned a student may become familiar with all of the common tools in 150 hours. We believe that more can be accomplished by this method than by having the men construct an engine, a pump, a speed lathe, or such.

In each of our laboratories where practical work is taught we have an instruction room with seats arranged amphitheatre style capable of seating from fifty to ninety men. Consider, for example, a class in machine tool work. The instructor has in the instruction room a motor driven machine of the type the men are to work upon. The instructor points out all of the difficulties likely to be encountered by the students when they begin their work on the machine and explains how to avoid such difficulties, thus answering beforehand the questions which each man would have asked if turned loose on the machine without previous instruction. Incidentally the number of instructors needed in a shop is reduced and a considerable saving made in the salary budget. It is of course necessary that one machine of each type should be mounted so that it can be moved into and out of the instruction room in a very few minutes.

In many schools it has been the custom to have the instruction in pattern work precede that in foundry work. We

have reversed this and now we feel confident that a short period of pattern work is all that is needed if preceded by a rather complete course in the foundry. After having had the foundry course and some eight hours of instruction in the pattern shop the students are given a drawing of a fairly complicated piece and told to make the pattern from which it is to be cast. Pattern work becomes thus more than mere skill in the use of wood working tools.

Research

The younger members of the staff should be encouraged to become candidates for a higher degree; they should be allowed to attend two courses per term and also be given time to undertake some research which may extend over two or more years and be credited toward a higher degree. The policy at M. I. T. under Dr. Stratton's leadership has been to foster original investigation and research whether of a purely scientific nature or of specific interest to an industry; some of our oldest professors having been relieved from nearly all of their teaching load in order to give their time to such problems.

Apportionment of Operating Budget

The apportionment of our operating budget amounting to $20,000 for the academic year 1927–1928 was as follows:

	Per Cent.
Library Books	2.5
Office Supplies	2.0
Supplies for Laboratory Repair Shop	2.9
Mimeograph	.5
Theses	1.9
Testing Materials Laboratory	7.8
Steam-Hydraulic-Compressed Air Laboratory	16.3
Gas Engine Laboratory	11.6
Power Measurement Laboratory	2.0
Textile Laboratory	5.8
Refrigeration Laboratory	4.9
Machine Tool Laboratory	28.8
Forge Laboratory	2.0
Foundry & Pattern Shop	3.3
Drawing Room Supplies	2.7
Trucking	2.0
Miscellaneous	2.0

The total salary budget for the teaching staff of the Mechanical Engineering Department consisting of

9 Professors
10 Associate Professors
5 Assistant Professors
19 Instructors
12 Assistants

for the year 1927–1928 was $147,922. The wages charged as accessory to teaching, including stenographers, clerks in instrument room and tool rooms, amounted to $4,895. That of engineers and helpers in the various laboratories, $12,347, making a total of $165,164.

It may be of interest to compare the actual teaching salary cost and the budget expenditure per student hour in the different branches of the department with the amount the student actually pays. This latter figure is 53.33 cents per student-hour, figured by dividing $400, the tuition, by 750 the average classroom, drawing room and laboratory hours per year.

Subject	Total Student Hrs. per Year	Teachers Salary per Student Hr. Cents	Budget Allotment per Student Hr.—Cents	Total Cents
Applied Mechanics	59,145	26.8	0	26.8
Thermodynamics Heat. Eng.	45,015	32.4	0	32.4
Drawing	32,940	22.3	1.6	23.9
Mechanism	23,355	38.0	0	38.0
Steam Compressed Air Hydraulic Power Measurement Refrigeration labs.	24,180	76.0	19.2	96.2
Gas Engine lab.	4,290	96.0	54.0	150.0
Testing Materials lab.	11,585	86.0	13.5	99.5
Machine Design	17,175	35.0	0	35.0
Machine Tool Foundry Forge Pattern	36,555	61.5	18.7	80.2
Professional Electives and Miscellaneous	36,285	106.0	0	106.0
	290,525 = Total student hours per academic year.			

It may be of interest to note that the total actual cost of instruction per year per student was $838 for 1927–28. The ratio of students to instructing staff of the college, including research assistants and research associates and lecturers who do little if any teaching, is 5.8 to 1; omitting the research associates, research assistants and lecturers the ratio figures as 7.35 to 1.

About eight years ago the authorities at M. I. T. began a study of the costs of teaching in the various departments. The figures obtained showed that the costs in three engineering departments bore the ratio 1–2.2—3.9. Of the three departments compared the one represented by the figure 2.2 should have the lowest in cost and the others should have been each at about the same figure, which, however, should have been somewhat higher than the lowest. As a result of this study the cost of operation in some departments has been reduced and at the present time the large engineering departments are operating at figures which are more nearly alike. In the small departments where the work is highly specialized and where the staff does no teaching to any but their own students the cost must necessarily be high as the ratio of students to instructors may be as low as three to one. The governing body at M. I. T. has requested that during every term each instructor turn in on a special sheet prepared by the administrative officers data from which the teaching salary per student hour cost may be figured.

It may also be of interest to discuss for a moment the method of accounting used in the mechanical engineering department by which we can tell at once what portion of the budget has been spent on any branch of the work.

Any member of the staff desiring to have material purchased for use in his branch sends his request to the head of the department where a stenographer makes out the necessary order which is sent to the Bursar of the college who does all of the purchasing. The order is made out on printed numbered forms, bound in groups of fifty pages, which we call requisitions, each order being composed of four copies, a white page 5″ x 8″—two yellow pages and a card (for file

purposes) so that four copies are obtained. The different pages are numbered serially. The white original and one yellow copy goes to the bursar who uses the white page as his order to the party from whom the goods are to be purchased. The yellow carbon copy goes into the bursar's files. The second yellow copy is kept by the member of the staff who desires the material, and the card or last copy is filed alphabetically in the office of the head of the department under the firm name from whom the goods are purchased. On receipt of the goods the member of the staff interested checks off the items against those listed on his carbon copy of the order so that when the bill is sent him he can put his O.K. on it and return it for final approval to the head of the department in time to save the discount for prompt payment. When the bill is approved the card order is moved from one file to a second file directly over the other, the amount of the bill and the date of approval being noted on the card. The bill itself is copied on a 5 x 8 card having the requisition number of the order in the upper right hand corner. The bill is also entered in a ledger. The amount of the bill is also entered in a second ledger under one of the twenty-five divisions into which for matters of keeping costs the accounting has been separated. On the first of each month the amount spent for each division during the past month is entered on a master sheet which tells one at a glance the total spent to date by the entire department and also by each division. The requisition cards for a period of one year fill a file 18″ deep which means a good many orders, many of which are of course for small amounts. We have found that the system works perfectly and that an average of not over thirty minutes' time per day is all that a stenographer needs in keeping the accounts, writing the requisitions, taking care of the bills, etc. The approval of bills by the head of the department is then a mere matter of signing his name.

To make such a system work successfully it is absolutely necessary that all orders for goods be made by requisitions obtained from one office. There are however emergencies when an order may be given by telephone or wire; in all such cases a confirmatory order is later put through.

Methods of Instruction in Classroom

There are many who believe in dividing a class into small sections containing not over twenty-five and in repeating the lecture as many times as the size of the class warrants. As a result of my own experience I believe that at the third repetion of a lecture the teacher cannot do himself justice and that the students suffer. In many of these small sections the classes are conducted as at West Point Military Academy. The instructor after outlining the next lesson sends the men to the blackboard to solve problems relating to the previous lesson or the instructor may hold an oral quiz. It is my belief that a section of 150 or 200 can be taught subjects like Applied Mechanics or Thermodynamics with the same success as could a section of twenty-five men. While it is true that not every instructor can hold the attention of a group as large as 150 there are in every organization men who can and who, if given a chance to try the large group, will never go back to the small sections. In my own staff there are men whose views on this matter do not agree with mine and who are carrying small groups; there are also a number who are heartily in favor of the large sections. In general an instructor who is to talk to a large group will spend more time in the preparation of his lecture than if he were to meet a small section. The quizzes and the board work are handled in this way: The instructor prepares for distribution at his lecture the statement of some five or six problems bearing on the work and illustrating points the class is supposed to know. The instructor has previously solved these problems. After explaining or outlining the work for the next lesson there may be twenty-five minutes of the hour left which he uses on the problems. He calls on a member of the class and asks him how to proceed in the solution of the first problem. The student outlines the steps and gives the instructor the numerical values to be put into the equations he may have mentioned. The instructor writes on the board the values given by the student. The entire class follows the work and any one is at liberty to raise a question if there is anything he does not understand. The instructor then calls on another member

of the class to outline the next step in the solution of the problem. If the student is in doubt as is also a second and a third whom he may call upon, it is evident to the instructor that there is some point he has not made clear in his previous lectures. After straightening this out, he goes on and in a short time has the problem stated in figures. As he has solved this beforehand any intermediate values needed in any later equations he can furnish.

By such a method it is possible to solve in thirty-five minutes from three to five problems which may be made up so as to be not only illustrative of the subject but which may give the student information of value to him. On the mimeographed sheet containing these problems a space is left in which the student may write down the equations used and the numerical values.

Whenever possible it is desirable to give students mimeographed notes covering any abstruse mathematical deductions not to be found in textbooks, thus avoiding the necessity of the student giving his attention to the copying of formulas, and making it possible for him to devote his whole time to the discussion given by the instructor.

A little more than a year ago what we call the Institute Committee, or the body of students controlling our student affairs, appointed a committee to report to the faculty, and to their own body, suggestions as to how our methods of teaching could be improved. The chairman of this student committee read his report to our faculty. It was an excellent report and the faculty has adopted many of the suggestions outlined. Inasmuch as the students on the committee were seniors who, at the time their report was made, had already been recommended for their degree, they had no hesitation in speaking freely and to the point.

In my remarks I have drawn freely on my experience during the last forty-three years as a member of the Mechanical Engineering staff at M. I. T. My predecessor, Professor Gaetano Lanza, under whom I served, was a man of broad vision who instilled many of his ideas into the staff working under him and much of the success which this department has had is in large measure due to him.

1929–30 MEMBERSHIP CAMPAIGN

On September 13 the Secretary wrote to the representative of the Society in each institution in the United States and Canada asking him to send to this office the names of all members of the engineering faculty. On this list the Secretary marked off the names of those persons who were members of the Society and to the others he sent invitations for them to join the Society enclosing an application blank for that purpose. The names of the faculty members of the following institutions were received.

On November 12 when this notice was sent to the printer invitations had been sent to 1,404 persons as indicated on the table. 108 applications have been received to date.

The Secretary asks you to seek the men in your institution who are not members of the Society and to second the invitation which he has extended. If your institution is not listed here, ask your local representative for the reason. We are printing an application blank herewith for the convenience of those who may not have any available.

F. L. BISHOP,
Secretary.

Institution	Application Blanks Sent	Applications Received
Akron, Univ. of	3	0
Alabama Poly. Inst.	15	3
Alabama, Univ. of	13	0
Antioch College	6	1
Arkansas, Univ. of	7	0
Armour Inst. Tech.	22	1
Beirut, Univ. of (Syria)	0	1
Bucknell Univ.	10	0
Calif. Inst. Tech.	26	0
Case School Applied Science	12	3
Cincinnati, Univ. of	33	0
Clemson College	0	1
Colorado Agri. College	13	0
Colorado School Mines	37	0
Columbia University	27	4
Colorado, Univ. of	29	3
Cooper Union	0	1
Cornell University	71	4
Detroit University	12	3
Drexel Institute	31	3
Ecole Polytechnique	28	1
Florida, Univ. of	13	0
Harvard University	14	1
Hawaii, Univ. of	4	0
Idaho, Univ. of	11	5
Illinois, Univ. of	32	2

Institution	Application Blanks Sent	Applications Received
Iowa State College	67	2
Iowa State University	5	2
Kansas State Agri. College	62	2
Kansas, Univ. of	31	0
Kentucky, Univ. of	0	1
Lafayette College	3	1
Louisville, Univ. of	5	0
Maine, Univ. of	14	0
Mass. Inst. Tech.	0	1
Michigan College Mines	16	0
Michigan, Univ. of	77	3
Michigan State College	0	1
Minnesota, Univ. of	39	1
Mississippi A. & M.	12	0
Mississippi, Univ. of	10	0
Missouri School Mines	19	2
Missouri, Univ. of	6	0
Nevada, Univ. of	18	0
Newark College of Eng.	16	1
New Hampshire, Univ. of	9	1
New Mexico A. & M.	6	0
New Mexico School Mines	8	0
North Carolina, Univ. of	0	1
North Dakota Agr. College	13	0
Nova Scotia Tech. College	8	0
Ohio State University	25	0
Oklahoma, Univ. of	23	0
Oregon Agr. College	23	4
Penna. State College	38	0
Pittsburgh, Univ. of	11	2
Porto Rico, Univ. of	9	0
Princeton University	8	2
Purdue University	92	4
Rochester, Univ. of	0	1
Rose Poly. Inst.	19	6
Royal Military Inst.	6	0
Saskatchewan, Univ. of	9	0
South Dakota State Coll.	6	0
Stevens Inst. Tech.	12	1
Stanford University	23	0
Swarthmore College	0	1
Texas A. & M.	45	6
Texas Tech. College	0	1
Texas, Univ. of	25	1
Tufts College	11	0
Tulane University	12	0
Union College	3	0
Vanderbilt University	0	1
Vermont, Univ. of	8	1
Virginia Poly. Inst.	36	2
Washington State Coll.	26	1
Wentworth Institute	0	1
Wisconsin, Univ. of	0	2
Worcester Poly. Inst.	13	1
Wyoming, Univ. of	6	1
Yale University	0	1
Industrial	0	12
November 12, 1929	1,404	108

Return to the Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Society for the Promotion of Engineering Education

Date.....

THE UNDERSIGNED desiring to become a member of THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

hereby agrees to conform to the requirements of membership, if elected, and submits the following:

STATEMENT OF QUALIFICATIONS

Full Christian Name and Surname.....
Print Last Name First Middle

Mailing Address (Number and Street).....

Post Office (City and State).....

Full Title of Professional Position.....
(Title) (Department)

Full Name of Institution.....

(To be Signed by Two Sponsors)

SPONSORS { .....
.....

* The number of applications requested by their representative.

NEW MEMBERS

BARLOW, WILLIAM E., Professor of Metallurgy and Metallography, Virginia Polytechnic Institute, Blacksburg, Va. C. A. Newman, J. B. Jones.

BERESFORD, HOBART, Professor and Head, Department of Agricultural Engineering, University of Idaho, Moscow, Ida. I. C. Crawford, J. Hugo Johnson.

BLAKE, DOUGLAS, Teaching Fellow of Mechanical Engineering, Washington State College, Pullman, Wash. G. E. Thornton, H. V. Carpenter.

BRENNEMAN, JESSE L., Professor and Acting Head, Department of Electrical Engineering, Kansas State Agricultural College, Manhattan, Kans. R. M. Kerchner, O. D. Hunt.

CROUSE, CHARLES S., Head, Mining and Metallurgical Engineering, University of Kentucky, Lexington, Ky. W. E. Freeman, C. O. Mock.

CRUIKSHANK, BARTON, Instructor in Engineering Laboratory, University of Idaho, Moscow, Idaho. H. F. Gauss, I. C. Crawford.

DILLINHAM, HARLEY C., Associate Professor of Electrical Engineering, A. & M. College of Texas, College Station, Texas. F. C. Bolton, M. C. Hughes.

DONOVAN, EDWARD T., Assistant Professor of Mechanical Engineering, University of New Hampshire, Durham, N. H. L. W. Hitchcock, E. H. Getchell.

ECKHARDT, CARL J., JR., Adjunct Professor of Mechanical Engineering, University of Texas, Austin, Tex. T. U. Taylor, J. A. Correll.

FITZGERALD, JOHN W., Instructor in Experimental Engineering, Cornell University, Ithaca, N. Y. W. M. Sawdon, D. S. Kimball.

GEIST, GILBERT A., Professor of Architecture, A. & M. College of Texas, College Station, Texas. F. C. Bolton, F. E. Giesecke.

GRENOBLE, HERBERT S., Associate Professor of Industrial Engineering, Virginia Polytechnic Institute, Blacksburg, Va. Paul T. Norton, Earle B. Norris.

GRIFFITH, JAMES R., Professor of Structural Engineering, Oregon Agricultural College, Corvallis, Ore. H. S. Rogers, G. N. Holcomb.

HALL, WALTER C., College Employment Representative, Illinois Bell Telephone Co., Chicago, Ill. R. I. Rees, O. W. Eshbach.

HESSE, HERMAN C., Head, Department of Mechanical Engineering, Newark College of Engineering, Newark, N. J. P. E. Scweizer, F. N. Entwisle.

KNIPMYER, CLARENCE C., Professor of Electrical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. C. Wischmeyer, J. B. Peddle.

LAMBERT, LEROY S., Assistant to the President, Northwestern Bell Telephone Company, Omaha, Nebr. R. I. Rees, O. W. Eshbach.

LYNN, ARTHUR E., Director, Guidance and Employment, Y. M. C. A., New York City. A. R. Cullimore, S. S. Edmands.

MCCARTER, WILLIAM W., Instructor in Mechanical Engineering, A. & M. College of Texas, College Station, Tex. F. C. Bolton, C. W. Crawford.

MCCOSH, STANLEY A., Instructor in Civil Engineering, A. & M. College of Texas, College Station, Tex. F. C. Bolton, J. J. Richey.

MCKEEMAN, CLYDE A., Instructor in Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio. F. H. Vose, T. M. Focke.

NICHOLSON, HUGH P., Instructor in Mining Engineering, University of Illinois, Urbana, Ill. H. H. Jordan, A. C. Callen.

OLMSTED, CHARLES T., Assistant Professor of Engineering Mechanics, University of Michican, Ann Arbor, Mich. H. C. Sadler, L. A. Hopkins.

ORR, JOSEPH A., Instructor in Civil Engineering, A. & M. College of Texas, College Station, Tex. J. J. Richey, L. E. Grinter.

PHILLIPS, MARK C., Associate Professor of Mechanical Engineering, Oregon Agricultural College, Corvallis, Ore. W. H. Martin, R. E. Summers.

RICHARDSON, DONALD E., Assistant Professor of Electrical Measurements, Armour Institute of Technology, Chicago, Ill. E. H. Freeman, John E. Snow.

SCHROEDER, WILLIAM, Instructor in Mechanical Engineering, University of Idaho, Moscow, Ida. I. C. Crawford, J. E. Buchanan.

SHERMAN, GEORGE W., JR., Associate Professor of Physics, Purdue University, Lafayette, Ind. J. D. Hoffman, M. W. Todd.

SMUTZ, FLOYD A., Associate Professor of Machine Design, Kansas State Agricultural College, Manhattan Kans. W. W. Carlson, A. J. Mack.

VONENDE, CARL L., Professor and Head, Department of Chemistry, University of Idaho, Moscow, Ida. I. C. Crawford, H. F. Gauss.

WARD, GERALD C., Instructor in Railway Engineering, University of Wisconsin, Madison, Wis. L. F. VanHagen, H. S. Janda.

WHITE, JOHN, Professor of Chemical Engineering and Chemistry, Rose Polytechnic Institute, Terre Haute, Ind. Carl Wischmeyer, J. B. Peddle.

WILLEY, EARL C., Instructor in Mechanical Engineering, Oregon State College, Corvallis, Ore. F. S. Baender, R. E. Summers.

WILSON, GROVER C., Assistant Professor of Steam and Gas Engineering, University of Wisconsin, Madison, Wis. G. L. Larson, L. A. Wilson.

COLLEGE NOTES

Carnegie Institute of Technology.—Work has started on the aerodynamic wind tunnel for testing aeroplane models and other aeronautic structures. The tunnel is of the latest and most improved type and will be placed in the room in Machinery Hall which formerly housed the Materials Testing Laboratory.

A new Materials Testing Laboratory has been added to the north wing of Engineering Hall and additional equipment has been secured. In this annnex also is planned a flume for testing model hydraulic structures. The old hydraulics laboratory has been remodeled.

Professor F. M. McCullough, head of the Department of Civil Engineering, will be away on leave during the first semester. William T. Crandell, assistant professor of Commercial Engineering, has been granted leave of absence to study at the University of Michigan.

New appointments to the engineering faculty are as follows: R. W. Coleman, Acting Assistant Professor, Commercial Engineering; R. E. Connelly, Instructor, Physics; Oscar G. Fryer, Instructor, Physics; R. T. Gabler, Instructor, Electrical Engineering; Maxwell Gensamer, Assistant Metallurgist; Cyril Wells, Assistant Metallurgist; Louis E. Winkelhaus, Instructor, Civil Engineering.

Colorado Agricultural College opens with the largest attendance it has ever had. The Engineering Division is considerably larger than in previous years. In the Department of Mechanical Engineering, Professor E. J. Mayer has resigned to go to New Mexico, and Professor H. H. Kob has taken his place.

The **University of Iowa.**—The new members of the faculty are: Edwin B. Kurtz, head of the department of electrical engineering; Huber O. Croft, head of the department of

mechanical engineering; F. W. Krotzer, assistant professor of electrical engineering; J. W. Howe, assistant professor of mechanics and hydraulics; O. J. Baldwin, instructor in engineering drawing; C. J. Posey, instructor in mechanics and hydraulics; H. E. Howe and J. A. Douglas, graduate assistants.

The College of Engineering put into operation this year a system of honors which recognizes excellence of scholastic work. It includes three grades of honors at graduation, "highest distinction," "high distinction" and "distinction," and undergraduate honors awarded to the highest five per cent of each class over their preceding work.

The attendance at the College of Engineering is increased 21 per cent over last year, which includes a 28 per cent increase in the freshman class. Two factors other than the large entering class account for the increase: (*a*) less than 10 per cent of students of good standing failed to return; (*b*) the upper classes were augmented by an unusually large influx by transfer from other institutions amounting to 16 per cent of their total, exclusive of those from junior colleges. The largest increase was in mechanical engineering.

A project of unusual interest was studied experimentally in the hydraulics laboratory during the summer, namely, the training of the Des Moines river at Ottumwa. The entire project was constructed in model form and studied with and without the improvements. It was probably the largest model investigation of river improvement that has ever been undertaken and the results were considered highly satisfactory. A similar study of less magnitude was one on the Upper Iowa river. Another study of interest was the hydraulics of flow over earth embankments, with particular reference to railroad embankment. Several minor hydraulic problems have been solved experimentally during the summer in the laboratory. Three studies now in progress are Mill Creek near Rock Island in coöperation with the U. S. Army Engineers; a silting problem on the Kickapoo river in Wisconsin and a power project in the Ozarks.

A project in the mechanical engineering department of

especial interest is the rating of riding quality of automobiles by means of a gyro accelerometer developed in the laboratories.

The **Kansas State Agricultural College** continues to enjoy a steady growth in its engineering division. On October 1, 1929, the enrollment totaled 990, which was an increase of 115 over the enrollment of a year ago. The total enrollment for the school year will be well over the one thousand mark.

More faculty changes have taken place the past year than usual, some going into the industries, others to better teaching positions. Those having left are Instructor H. L. Oakes, Civil Engineering Department; Prof. Benj. Spieth, Applied Mechanics; Professor Roy Bainer, Agriculturing Engineering; Instructor C. L. Carjola, Architecture; Professor I. A. Wojtaszak, Applied Mechanics; Professor Harold Allen, Applied Mechanics; Instructor C. M. Leonard, Mechanical Engineering; Instructor F. W. Doelz, Shop Practice; Laboratory Assistant E. E. Larson, Applied Mechanics.

The places left vacant have been filled by the following: Instructor R. F. Morse, Iowa State College, Civil Engineering; Instructor Gerald Pickett, Oklahoma A. & M., Applied Mechanics; Instructor C. A. Logan, K. S. A. C., Agricultural Engineering; Instructor J. T. Ware, Georgia Tech., Architecture; and Instructor L. H. Koenitzer, Iowa State, Applied Mechanics.

In the Machine Design Department a new position has been created which has been filled by Instructor E. H. Hahn from Iowa State.

Six new positions have been created as part time instructors and research assistants. Two of these are the results of fellowships. One has been established by the Ash Grove Lime & Portland Cement Company in the Department of Applied Mechanics for the purpose of investigating properties of early strength cement concretes and mortars. The other fellowship is sponsored by the Kansas Committee on Relation of Electricity in Agriculture and is in the Department of Agricultural Engineering.

Professor R. G. Kloeffler, head of the Department of Electrical Engineering, is on sabbatical leave for advanced study at the Massachusetts Institute of Technology. Professor J. L. Brenneman is acting head. Instructor C .C. Rice, K.S.A.C., is temporarily engaged to help carry the teaching load of the department. A new textbook on Direct-current Machinery, written by Professors Kloeffler and Brenneman, is being used in the classes for final corrections before going to press.

The completion of the new power plant, costing $315,000, has made available space for expansion of several departments. Enlarged laboratories for testing materials of construction and for hydraulics have been provided for the Department of Applied Mechanics. The Mechanical Engineering Department has extended its Steam and Gas Laboratory to include the space formerly occupied by the old power house units. A new 300-h.p. electrical dynamometer for testing aeroplane engines is a recent addition to the equipment of the Mechanical Engineering Department.

University of Maine.—Resignations of L. B. Hoyt, R. N. Pollock, Alvin Sloane, D. H. Stevens, Harold C. White and A. O. Willey were received during the summer.

Two new members have been appointed to the Civil Engineering Staff: W. H. H. Newell, Assistant Professor; and L. D. Stephenson, Instructor. Mr. Newell has been with the General Motors Institute of Technology at Flint, Michigan; Mr. Stephenson, with the Tennessee Highway Department.

T. A. Sparrow, formerly Instructor in Engineering Drawing, is now Instructor in the Mechanical Engineering Department.

Ralph A. Sawyer, a graduate of Norwich University, succeeds Mr. Sloane as Instructor in Engineering Drafting. Mr. Sawyer has been in the employ of the New York Central Railroad Company.

W. S. Evans is with us after spending the past half year on sabbatical leave at the University of Michigan.

E. J. Bogan, Ferderick J. Guerin and Millard G. Moore are new members of the Chemistry staff. Mr. Bogan received his

M.A. degree at Princeton this last June. Mr. Guerin holds a Ph.D. from New York University. Mr. Moore, a Graduate Fellow in the department, comes from the New York State Agricultural Experiment Station.

Earl M. Dunham, formerly a member of the Physics Department, has joined the engineering faculty as Instructor in Engineering Drafting.

H. D. Watson attended the S. P. E. E. Summer Session on Mechanical Engineering at Purdue University.

A. S. Hill continued work toward a master's degree at the University of Michigan.

I. H. Prageman designed and laid out equipment for the new factory building of the Ra Var Corporation, Newark, N. J., which is being financed by Anthony Biddle, Jr.

A. C. Lyon was inspector of concrete bridge construction for the Maine State Highway Commission at Mapleton, Maine.

Paul Cloke, W. S. Evans, A. C. Lyon, H. D. Watson and Chas. P. Weston attended the annual convention of the Society in June. Dean Cloke is Chairman of the New England Section.

The personnel work of the college has been placed in direct charge of Professor Evans. Mrs. Rose S. Ramsey, his assistant, has had extensive experience in personnel work at Columbia. The Technology Personnel Room is on the second floor of the M. C. A. Building.

The somewhat famous old locomotive, the "Lion," which reposed under the grandstand several years, is now on exhibition in Crosby Laboratory.

The electrical engineering power laboratory has been enlarged and greatly improved.

The **University of Southern California.**—Evidences of greatly stimulated interest in mechanical, chemical and petroleum engineering are seen in the comparative tables of enrollment for the past three years in the College of Engineering of the University of Southern California. While enrollment in electrical engineering showed a nominal increase,

there was a slight falling-off in civil engineering The total enrollment increased sharply during the three years, with 300 at the present time against 251 last year and 226 in the first semester of 1927–28.

Increasing interest in aviation is believed to account for the rise of registration in mechanical engineering from seven students in 1927–28 to 20 in 1928–29 and 58 in 1929–30. Opportunities for the engineer in the oil industry, and the enlargement and strengthening of the curriculum in this division have resulted in the increase from 20 students in the division of petroleum engineering last year to 49 at present, it is believed. Largely the same factors have governed the increase in chemical engineering from 17 in 1927–28 to 32 in 1928–29 and 42 in 1929–30.

In the face of these sharp increases the division of electrical engineering has held its own with 93 students in 1927–28, 81 in 1928–29 and 87 in 1929–30. Registration in civil engineering has fluctuated from 70 in 1927–28 to 80 in 1928–29 and to 64 at present.

To cope with the problems of a rapidly growing technical school in a rapidly expanding community the College has increased its faculty by four. The new appointees are John Franklin Dodge, petroleum engineer of the Standard Oil Company of California and nationally recognized authority on gas conservation, as professor of petroleum engineering; David M. Wilson, from 1924–29, assistant engineer in charge of drainage and irrigation with the Central Aguirre Sugar Company, Porto Rico, as assistant professor of Civil Engineering; Gilbert H. Dunstan, instructor in civil engineering at Tulane University, as instructor, and Sidney F. Duncan, who holds the degrees of B. S. in M. E. and B.S. in E. E. from California Institute of Technology, as instructor in mechanical and electrical engineering.

Tufts College.—The Electrical Engineering Department is extending its research work this year, particularly in the field of radio communication in which work is being done in both the long wave and short wave transmission bands.

On account of this work Dr. Gleason W. Kendrick, Sc.D., has joined the department staff. Dr. Kenrick was graduated from the Massachusetts Institute of Technology in 1922 with degrees of S.B. and S.M. and has been associated with the American Telephone and Telegraph Co. and the New York Edison Co. He has been a teacher at the Massachusetts Institute of Technology and comes to Tufts from the Moore School of Engineering of University of Pennsylvania. Dr. Kenrick will have charge of the course in Communications and will carry on research work in radio transmission in which he has been engaged for the past two years.

The research work now under way consists of measurements of the height of the Kenelly-Heaviside Layers for short waves and long waves. Automatic recording equipment used in combination with an antenna and rotating loop is being used to study transmission phenomena on the long waves, and pulser signals recorded by means of special receiving equipment and an oscillograph are being used with the short waves.

During the past year the facilities of the High Tension Laboratory have been augmented by bridge and current measurement equipment of high precision developed by the department staff. With this equipment, suspension and pin type insulator units have been studied to obtain basic information, and it is expected that later a study of deterioration will be undertaken based on tests of insulators that have been in service for varying periods of time and supplemented by accelerated life tests

SECTIONS AND BRANCHES

The **New England Section** met at Harvard University, on Saturday, November 9th, 1929.

9:30 A.M. The Harvard Engineering School Faculty had arranged a complete tour of the University, including the Medical School, the School of Public Health and the Graduate School of Business Administration.

12:00 M. Buffet Lunch, Harvard Union. After lunch a visit was paid to the collection of glass flowers in the University Museum.

2:00 P.M. Afternoon Session, 110 Pierce Hall.

Orientation of Students to Industry. R. S. Doherty, Consulting Engineer, General Electric Co., E. S. Mansfield, Head of Educational Bureau, Edison Electric Illumination Co., of Boston.

Summer Session for Teachers of Mechanical Engineering at Purdue University. George A. Stetson, Assoc. Editor Am. Soc. of Mech. Eng., C. E. Davies, Acting Secretary Am. Soc. of Mech. Eng., P. W. Swain, Associate Editor, *Power.*

4:00 P.M. Detailed examination of the work and facilities of the Harvard Engineering School.

6:30 P.M. Dinner, Harvard Union.

What Effect Has the Investigation of Engineering Education Had on My Institution? H. J. Hughes, Dean of Harvard Engineering School, General Discussion.

Purdue Section.—At a meeting of the Section on October 17, the following officers were elected for the coming year: President, Professor William Marshall, Head of the Department of Mathematics; Secretary, Professor M. W. Todd, of the School of Civil Engineering. The section enjoyed a very interesting and profitable discussion of Director Wickenden's report, lead by Professor D. D. Ewing of the School of Electrical Engineering, and by Dean L. A. Scipio of Robert College, Constantinople.

BOOK REVIEWS

Fundamentals of Electrical Engineering. WM. S. FRANKLIN AND LYMAN M. DAWES, both of Massachusetts Institute of Technology. Franklin & Charles, Lancaster, Pa. 512 pages.

This book is divided into 16 chapters. Each chapter is well written with appropriate illustrative diagrams but no photographs. The diagrams are arranged to illustrate fundamental principles.

At the end of each chapter is a large number of problems designed to drill the student in the fundamentals previously set forth in the chapter.

The book covers the whole field of Electrical Engineering from circuits through Radio principles and storage batteries, to direct and alternating current Machinery. This book should be very helpful in the conduct of courses intended for non-electrical students.

R. C. G.

Steam Tables and Diagrams. MARKS AND DAVIS. Longmans, Green, N. Y. New edition, 1929. 110 pp.

This is a reprint of the well known Marks and Davis tables, with the addition of a short appendix enabling the user to take advantage of the more recent developments in our knowledge of the properties of steam at high pressures and temperatures. Differences between the older values of these properties, and those established by recent research are given in the form of correction charts in the appendix. By permission of the American Society of Mechanical Engineers Keenan's Mollier chart is reproduced.

The new edition should meet all the needs of users and designers of steam apparatus until such time as further research may necessitate a revision of the Keenan chart.

J. A. D.

Introduction to Physical Optics. By JOHN KELLOCH ROBERTSON, F. R. S. C. (422 pages.) Published 1929 by D. Van Nostrand Co.

The book fulfills admirably the demand for a text intermediate in difficulty between the work of a first year course and texts like Houstoun's "Theory of Light" which does not restrict the field to prisms, lenses, and optical instruments. The author has succeeded in treating difficult matter in a simple, comprehensive way, and his drawings are certainly enlightening. Graphical explanations such as those of the eye ring and diffraction phenomena leave little to be desired. The discussion of wave motion is excellent and the numerous solved examples satisfy the desire expressed many times by students that theory and practice be more closely coördinated. The many problems form a valuable part of the text.

A more rigid treatment of Gauss' points is desirable. The author would save the reader considerable time if, after a reference to a particular plate, the pages were also mentioned.

W. N. ST. P.